TM 5-3805-256-35

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DIRECT AND GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

LOADER SCOOP TYPE, PNEU TIRED, DIESEL ENGINE DRIVEN, HINGED FRAME STEER, WITH 2-1/2 CU YD MULTI-PURPOSE BUCKET, ALLIS CHALMERS MODEL 645M FSN 3805-051-9359

This reprint includes all changes in effect at the time of publication; changes 1 through 3.

HEADQUARTERS, DEPARTMENT OF THE ARMY
JULY 1968

SAFETY PRECAUTIONS

BEFORE OPERATION

Keep equipment free of oil, grease, and dirt to insure nonslip control.

Do not smoke or use an open flame in the vicinity when servicing the batteries. Batteries generate hydrogen, a highly explosive gas.

Check loader before starting. Make sure area is clear of personnel before moving loader. Sound horn before moving loader.

Never operate loader until air pressure gage indicates between 75 and 125 psi or if low air pressure warning buzzer is sounding.

Remove cold weather starting aid cylinder when loader is to be operated in warm climates to prevent inadvertent injection of fluid into the engine.

Do not crank engine more than 30 seconds continuously without allowing a two minute cooling off period.

DURING OPERATION

Operate loader only in a well ventilated area.

Do not use bucket as a brake.

Never get on or off a loader that is in motion. Do not permit anyone to ride on the outside of the loader. Watch for ground crew or other personnel on foot while moving the machine.

Do not move clutch cutoff lever unless brake pedal is fully released.

Do not down shift from high range to low range at speeds in excess of 5 mph.

AFTER OPERATION

Always lower bucket to the ground when loader is not in use. Place all levers in neutral position.

Set parking brake when parking loader. Block wheels when parking on a grade.

Report and correct any conditions that may result in injury to personnel or damage to the machine.

Stop machine and shutoff engine before lubricating, adjusting, or servicing. Always install safety locking bar before servicing.

Keep equipment free of dirt, grease, and oil.

Before servicing any part of the loader electrical system, disconnect the battery ground cable.

Exercise caution when removing the radiator cap while engine is hot. Quick removal may allow hot coolant to escape and may cause serious injury to personnel.

CHANGE
No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., *22 January 1970*

Direct and General Support and Depot Maintenance Manual

LOADER SCOOP TYPE, PNEUMATIC TIRED, DIESEL ENGINE DRIVEN, HINGED FRAME STEER, WITH 2-½ CU. YD. MULTI-PURPOSE BUCKET, (ALLIS CHALMERS MODEL 645M) FSN 3805-051-9359

TM 5-3805-239-35, 5 July 1968 is changed as follows:

Page ii. Chapter 9 is superseded as follows:

		Paragraph	Page
CHAPTER 9.	ENGINE ACCESSORIES REPAIR INSTRUCTIONS		
Section	I. Starter	9-1, 9-2	9-1
	II. Alternator	9-3, 9-4	9-6
	III. Reverse polarity protector	9-5, 9-6	9-10
	IV. Voltage regulator	9-7, 9-8	9-10
	V. Miscellaneous electrical components	9-9, 9-10	9-11

Page 1-1. Scope, paragraph 1-1a, delete the *a* in front of the paragraph.

Page 1-1. Paragraph 1-1b is rescinded.

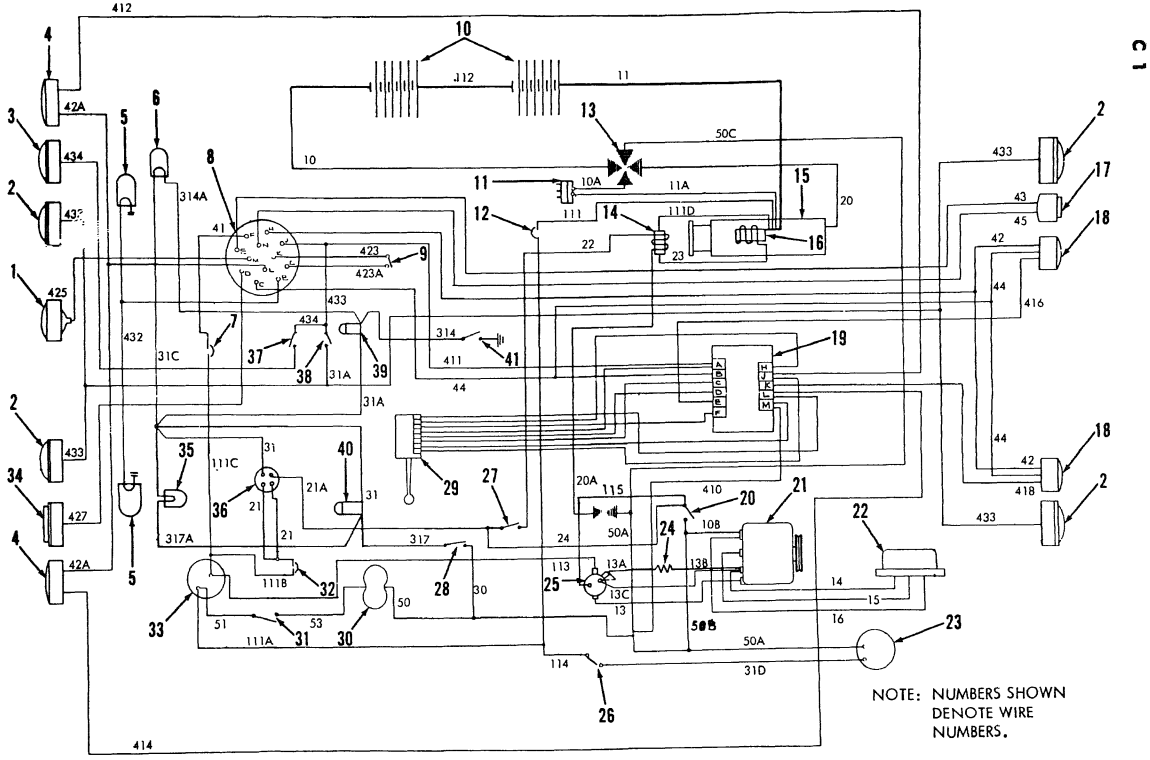
Page 1-1. Paragraph 1-2 is superseded as follows:

1-2. Forms and Records

a. Maintenance forms, records, and reports which are to be used by maintenance personnel at all levels are listed in and prescribed by TM 38-750.

b. Report all errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028, Recommended Changes to Publications, and forwarded direct to the Commanding General, U. S. Army Mobility Equipment Command, ATTN: AMSME-MPP, 4300 Goodfellow Boulevard, St. Louis Mo., 63120.

Page 1-2. Figure 1-1 is superseded as follows:



MEC 3805-239-35/1-1

Figure 1-1. Schematic wiring diagram.

Page 1-3. (3) Transmission, Engine flywheel to flex plate screws. Change torque value from 41-49 to read 33-40 ft. lbs.

Page 3-40. Table 3-1, change to Table 3-2.

Page 9-6. Section II, Generator, paragraphs 9-3 thru 9-4*a* (6) (*d*) are superseded as follows:

Section II. ALTERNATOR

9-3. General

a. The generating system of the loader consists of an alternator (21, fig. 1-1), a voltage regulator (22), a polarity protector (25), and the batteries (10). The system is basically the same as a direct current system.

b. In the alternator the magnetic field is rotated and the conductor is stationary. Cutting of the flux lines by the magnetic field induces a voltage in the conductor and out through the system.

c. The current as produced by the alternator is alternating current. Six diodes mounted in the alternator rectify the current to direct current for use in the 24-volt system (fig. 1-1).

d. The alternator brush holder assembly is internally wiped with a capacitor as an integral part. This capacitor supplies the radio interference suppression.

9-4. Alternator

a. General. Tests should be performed on a suspected faulty alternator before removing alternator. Tests will help isolate trouble and aid in determining repair(s) required. Alternators and voltage regulators should be tested on the vehicle using circuit conductors and accessories that are a permanent part of the charging system.

b. Equipment Required.

(1) Test set, generator and voltage regulator, automotive, measurement of voltage and current in low tension circuits of 6/12/24 volt type tests.

(2) Multimeter, range 0 to 5000 v., a.c./d.c.

(3) Resistor, 1/4 ohm, 75 watt.

c. Preliminary Inspection. Before actual on vehicle testing commences, check charging system and batteries to eliminate possible difficulty.

(1) Test batteries. Must be at least 75 percent of full charge (1.240 specific gravity).

(2) Inspect batteries for loose cables, corrosion, and other visible damage. Be sure batteries are secure.

(3) Inspect all cables between batteries, starter and engine ground, being sure they are properly connected and/or attached, and free of corrosion.

(4) Inspect all leads, junction switches and panel instruments of charging system for frayed wires, loose connections, breaks, and missing components. Correct all deficiencies.

(5) Inspect engine drive and alternator driven pulleys for loose mounting, breaks, and cracks.

(6) Inspect drive belt for grease or oil, frays or breaks and looseness. Clean, replace or tighten as required to eliminate slippage under load.

CAUTION

Do not disconnect alternator output lead or voltage regulator while alternator is operating. Do not ground alternator field terminal.

d. Battery Voltage Test (Switch off—engine not running).

(1) Connect voltmeter as shown in figure 9-7; meter should indicate 24.0 to 26.4 volts.

(2) If low voltage is noted, check and tighten circuit connections.

(3) Recharge battery if necessary.

Page 9-7. Figure 9-7 is superseded as follows:

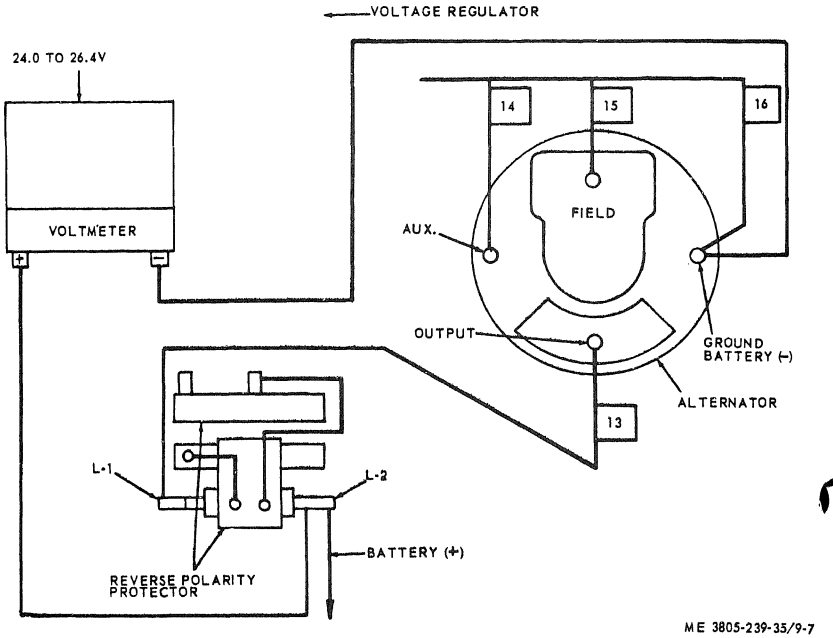


Figure 9-7. Battery voltage test hookup.

e. Isolation Diode Test (Switch off—engine not running).

(1) Connect voltmeter as shown in figure 9-8.

(2) Connect short jumper cable across load terminals L-1 and L-2 of reverse polarity protector.

(3) Voltmeter should indicate zero volts.

(4) Voltmeter readings above zero volts indicates improper output cable connections, or a shorted isolation diode. (Do not allow terminal of output lead to touch heat sink, figure 9-9.)

NOTE

An open alternator isolation diode may show good under this test.

(5) Refer to figure 9-10 and replace isolation diode, retest.

(6) If zero voltage is indicated on voltmeter proceed to next test after removing jumper cable from terminals L1 and L2.

NOTE

A shorted alternator isolation diode will cause the reverse polarity protector to remain energized when the engine is shut down.

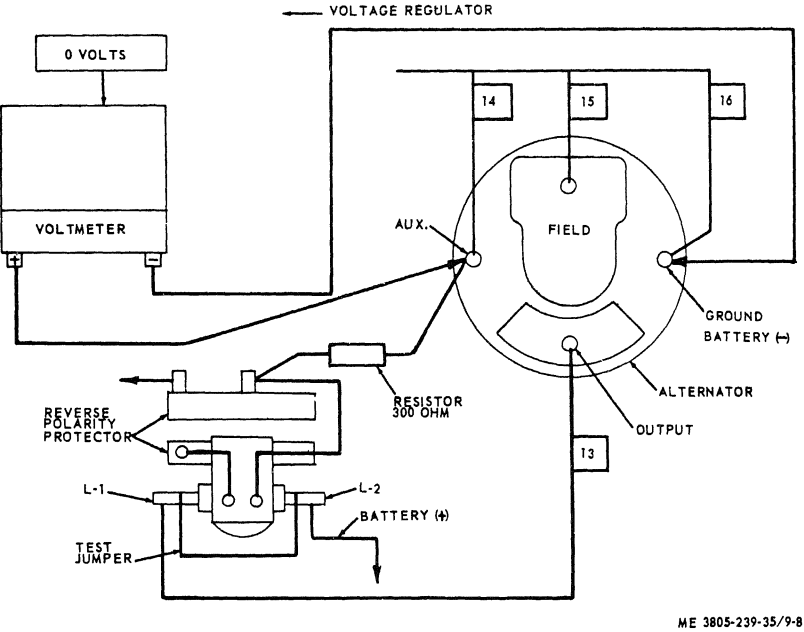


Figure 9-8. Battery voltage test hookup.

Page 9-7. Figure 9-9 is superseded as follows:

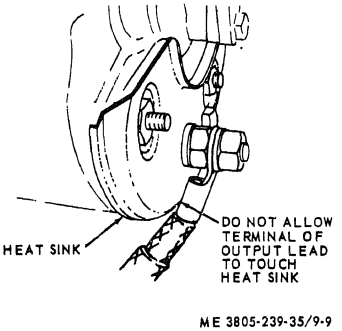


Figure 9-9. Output lead connection.

Page 9-8. Figure 9-10 is superseded as follows:

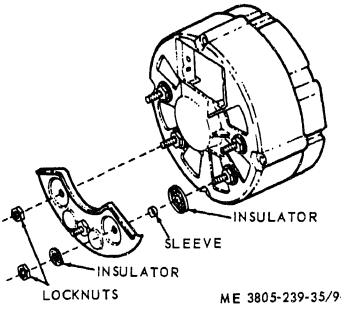


Figure 9-10. Isolation diode insulator installation.

f. Excitation Voltage Test (Switch on—Engine not running).

(1) Connect voltmeter as shown in figure 9-11, turn key switch on.

(2) Voltmeter should indicate 9.0 volts ± 1.0v. High voltage, above 10 volt indicates regulator or field winding (rotor) has open circuit.

(3) Place jumper from auxiliary terminal to field terminal; if jumper provides correct voltage, replace voltage regulator and retest.

NOTE

The voltage regulator may have an open circuit.

(4) If jumper use does not provide correct voltage, check brushes and slip rings for dirt, broken or worn brushes.

(5) If retest with clean brushes and slip rings does not provide correct voltage, alternator must be removed for repair.

(6) Should voltmeter indicate 0 volts, move positive lead of voltmeter to points indicated in table 9-1.

Table 9-1. Voltmeter Readings

Point	*Voltmeter Should Indicate*
A	Battery voltage is correct reading (24.0 to 26.4 volt)
B	Approximately 1.0 volt less than battery voltage. If 0 volts is noted here, diode in reverse polarity protector is open. Replace reverse polarity assembly and retest.
C	Same as noted at Point B.
D	9.0 ± 1.0 volt. If 0 volt is indicated here, replace excitation resistor and retest. If 2.5 to 3.0 volts indicated, 33 ohm resistor in polarity protector is open. If 7.2 to 7.7 volts indicated, the 150 ohm resistor is open.

Page 9-9. Figure 9-11 is superseded as follows:

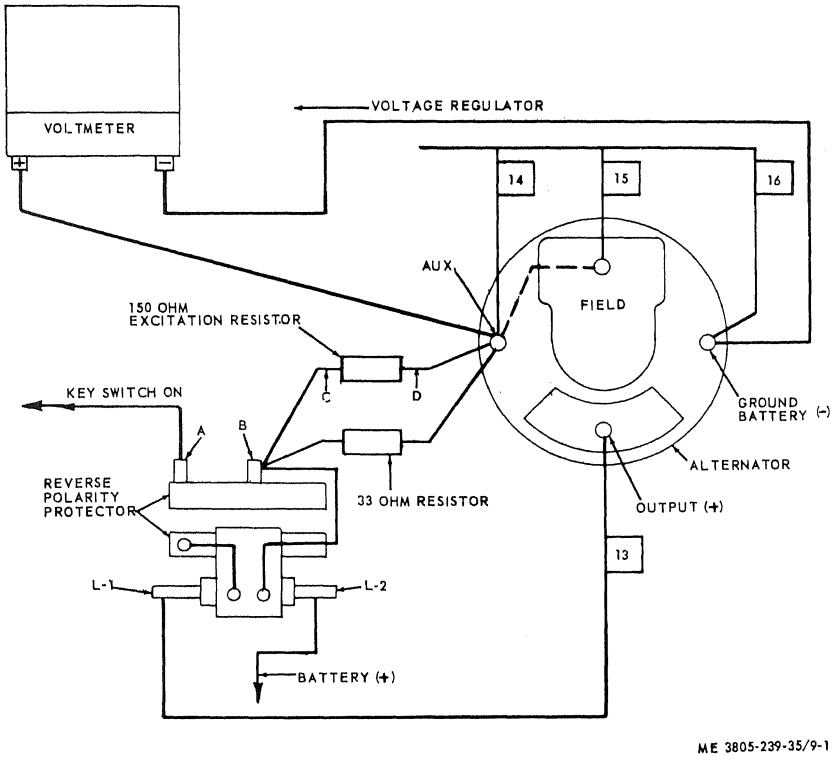


Figure 9-11. Excitation voltage test.

g. Open Isolation Diode Test (Switch on—Engine running).

(1) Connect voltmeter as shown in figure 9-12 with "Test A" wire auxiliary terminal of alternator.

(2) Start engine, set speed at approximately 1000 engine RPM.

(3) Measured voltage should read 29.6 ± .6 volt.

(4) Relocate "Test A" wire to alternator output terminal (Test B) (Engine speed at approximately 1000 RPM).

(5) Measured voltage at "Test B" connection should be 1 volt less than step 3 above, ± .6 volt.

(6) If the voltage at the output terminal (Test B) is battery voltage, (24.0-25 volts) the isolation diode is open. Disconnect ground cable

from battery and replace alternator isolation diode.

(7) Retest points 1 thru 5 above.

CAUTION

An open isolation diode cannot provide battery charge and may damage the alternator rectifier diodes and the voltage regulator.

Page 9-10. Figures 9-12 through 9-24 added.

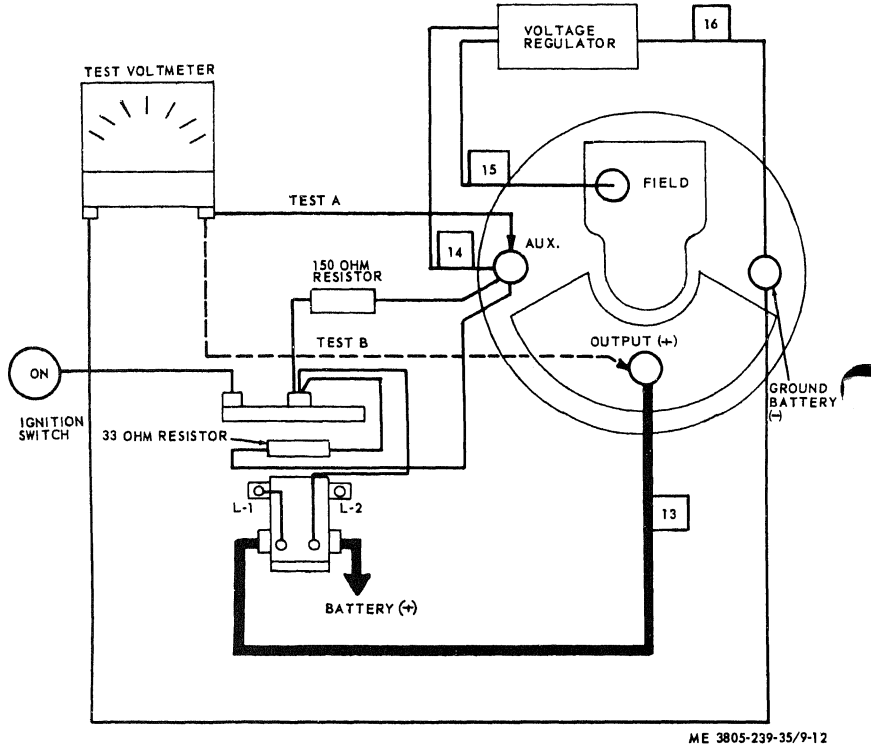


Figure 9-12. Open isolation diode test.

h. Field Current Draw Test (Switch off—Engine not running).

(1) Place ammeter on 0 to 5 ampere scale.

(2) Set field rheostat knob to maximum resistance.

NOTE

Field rheostat protects ammeter in case the rotor is shorted.

(3) Remove No. 15 lead from alternator field terminal.

(4) Connect field rheostat and ammeter as shown in figure 9-13.

(5) Slowly reduce rheostat resistance, continuing to minimum if ammeter does not exceed 3.0 amperes. (2-3 amperes is normal.)

(6) Ammeter indication without rheostat resistance is field (rotor winding) current.

(7) Low or unsteady ammeter reading may be due to dirt on slip rings or worn brushes. Clean and retest.

(8) High ammeter reading indicates shorted slip rings or rotor winding, requiring alternator repairs.

(9) Remove field rheostat and ammeter after test, reconnect No. 15 lead to field terminal.

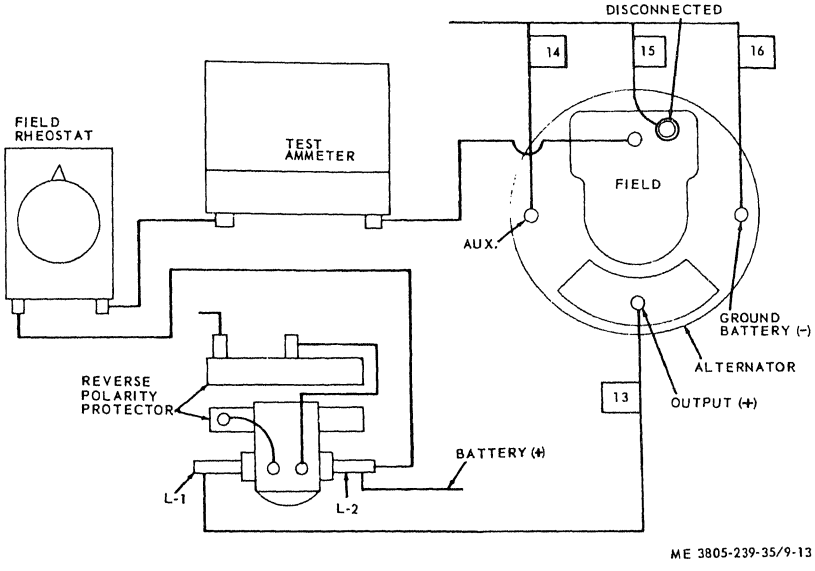


Figure 9-13. Field current draw test.

i. *Voltage Regulator Setting Test (Switch on —Engine running).*

(1) Connect test ammeter and voltmeter as shown in figure 9-14.

(2) Start engine, turn on full accessory load to increase electrical load, run at approximately 1000 engine RPM for a few minutes to stabilize temperature of components.

(3) Turn accessory load off.

(4) Observe ammeter and voltmeter readings.

(*a*) If ammeter indicates less than 10 amperes, and voltmeter indicates 28.4 ± .6 volts, refer to TM 5-3805-239-12 and adjust regulator.

(*b*) If ammeter indicates more than 10 amperes, stop the engine and connect a 1/4 ohm registor as shown in figure 9-14. Start engine and set speed at approximately 1000 RPM.

(c) Voltage indicated by voltmeter should be 28.4 ± .6 volts.

(d) High voltage indications may be caused by loose connection on number 16 wire (regulator ground wire) or, faulty regulator, replace and retest.

(e) Remove 1/4 ohm resistor from circuit.

(f) Low voltage may be due to improperly operating voltage regulator, replace and retest.

(5) Refer to TM 5-3805-239-12 for voltage regulator adjustment procedures.

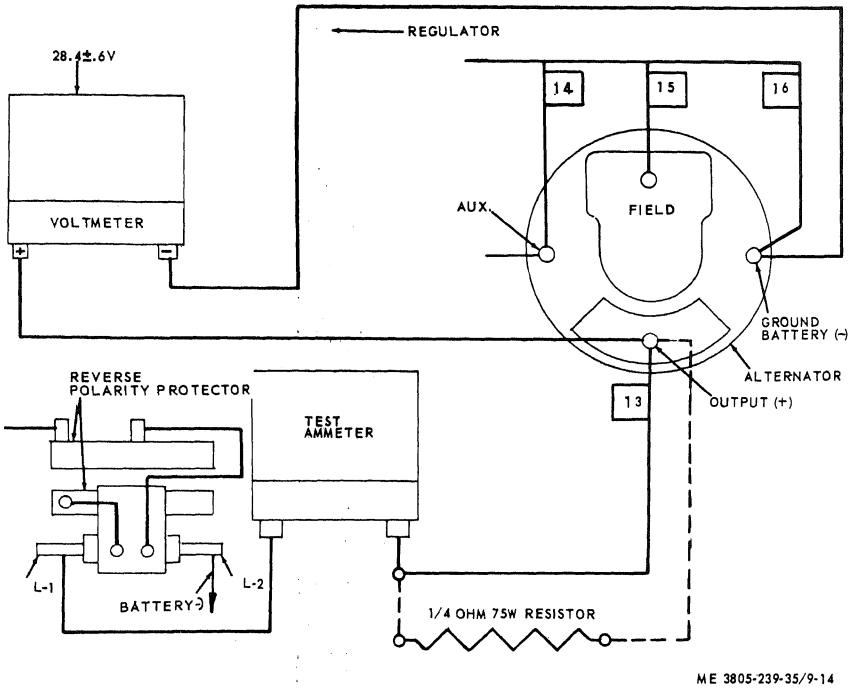


Figure 9-14. Voltage regulator setting test.

j. Alternator Output Test (Switch on—Engine running).

(1) Connect ammeter and voltmeter as shown in figure 9-15.

(2) Place carbon pile control knob in off position, connect load cables across battery posts.

(3) Start engine, set throttle to approxi-

mately 1000 engine RPM, allow a few minutes stabilize temperature of components.

NOTE

If carbon pile is not available, apply full electrical accessory load to the battery.

(4) Gradually apply carbon pile load to battery, the voltmeter should stay above 25.0 volts with the ammeter indicating a minimun. of 25.0 amperes.

(5) Remove carbon pile load from battery immediately after testing to avoid discharging batteries.

(6) Alternator should be removed from

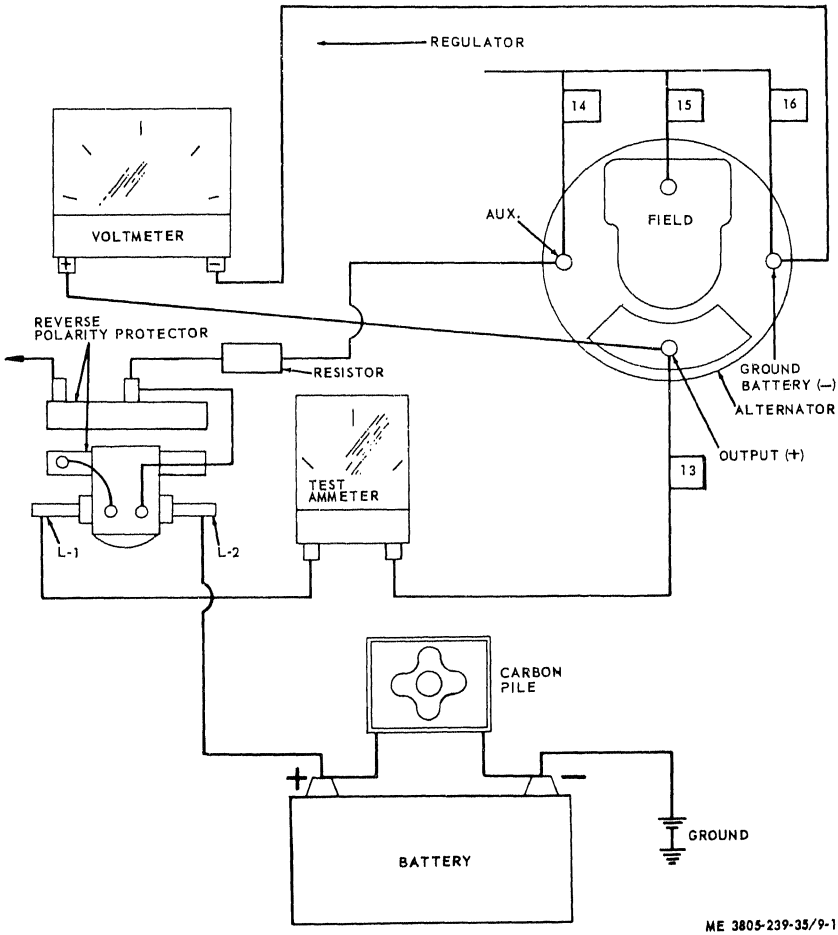


Figure 9-15. Alternator output test.

the engine for repairs if it cannot provide the minimum (hot) output of 25.0 amperes.

Page 9-8. Paragraph 9-4, subparagraph *b* is changed to *k*; reletter remaining subparagraphs as follows: c to *l*, *d* to *m*, *e* to *n*, *f* to o, and *g* to *p*.

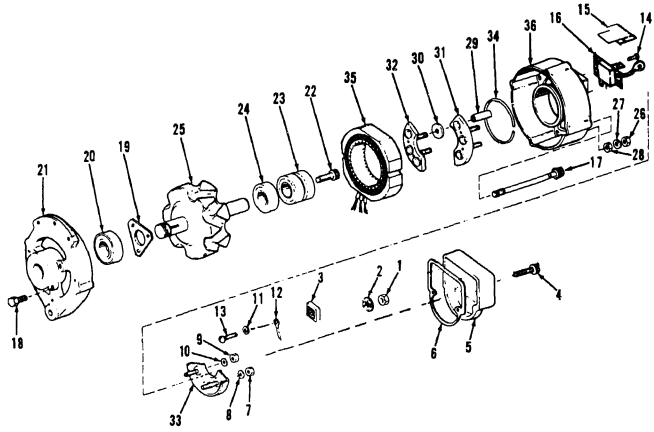
Page 9-8. Paragraphs 9-4*l* (1) and (2) are superseded as follows:

(1) Remove nut (1, fig. 9-16), washer (2) and insulator (3) from field terminal.

(2) Remove tab plate, two screws (4), and remove rear cover (5) and gasket (6).

Page 9-8. Paragraphs 9-4*l* (12) thru (15) are superseded as follows:

(12) Remove four nuts (26), insulating washers (27), and nuts (28). Remove rear housing (36) from diodes and stator (35).



1 Nut, 10-24
2 Washer, insulating
3 Insulator
4 Screw, 8 x 3/4 in. (2 rqr)
5 Rear cover
6 Gasket
7 Nut, 1/4-20
8 Insulator
9 Nut, 10-24 (2 rqr)
10 Insulator (2 rqr)
11 Washer, flat, No. 10
12 Field wire
13 Screw, 10-24
14 Screw (2 rqr)
15 Insulator
16 Brush assembly
17 Screw 10-32 x 3-1/8 in. (4 rqr)
18 Screw (3 rqr)
19 Bearing retainer
20 Front bearing
21 Front housing
22 Screw
23 Slip ring assembly
24 Bearing
25 Rotor assembly
26 Nut, 10-24 (4 rqr)
27 Washer, insulating (4 rqr)
28 Nut (4 rqr)
29 Insulator (4 rqr)
30 Washer, insulating (4 rqr)
31 Positive diode
32 Negative diode
33 Isolation diode
34 Bearing retainer
35 Stator assembly
36 Rear housing

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Figure 9-16. Alternator, exploded view.

(13) Test rectifying diodes (31 and 32) with a reliable diode tester, refer to figure 9-17. If diodes are shorted, replace diodes as an assembly. Do not replace individual diodes.

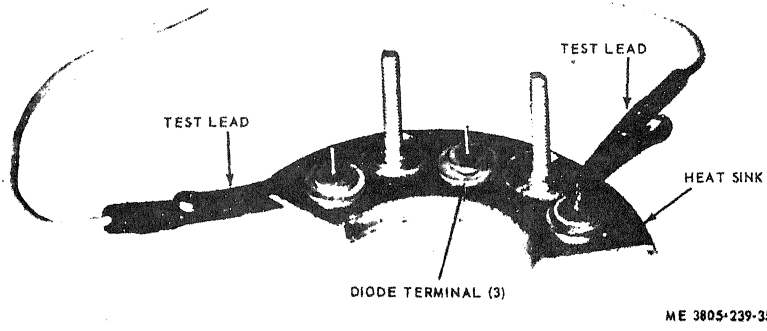


Figure 9-17. Diode test hookup.

(14) Check stator (35, fig. 9-16) for grounding with an ohmmeter. Place one probe on the stator lead, the other on stator laminations. The meter should show no continuity. If stator is grounded, replace stator, see figures 9-18 and 9-19.

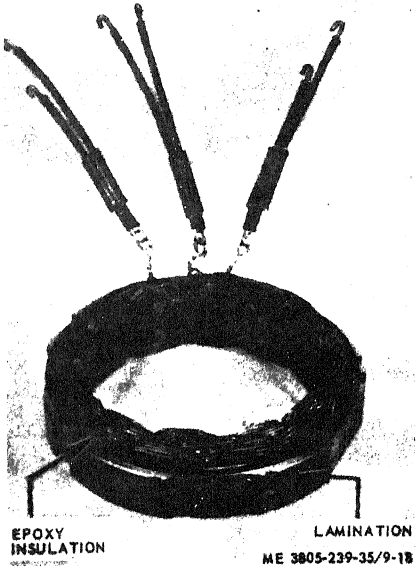
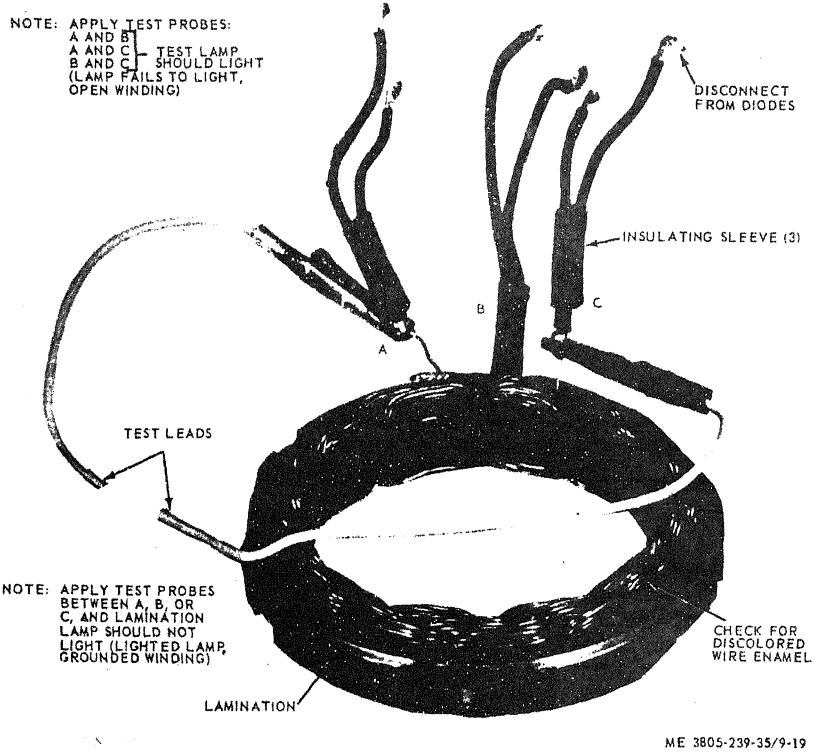


Figure 9-18. Stator assembly.



9-19. Stator test hookup.

(15) Refer to figure 9-20 and unsolder leads from diodes as follows:

(*a*) Tag diode and stator leads for correct installation.

(*b*) Grasp diode lead with a pliers between the diode and stator to apply better heat dissipation.

(*c*) Unsolder leads from diode. Solder new diode to stator leads.

NOTE

Positive diode (31, fig. 9-16) will have red printing on body. Negative diode (32) will have black printing.

(*d*) Use only rosin core solder to solder leads. Coat solder joints with lacquer.

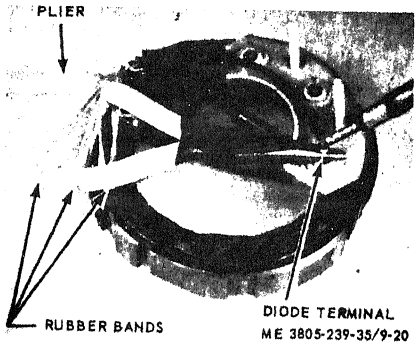


Figure 9-20. Diode, removal and installation.

Page 9-10. Paragraph 9-4*n* (5) is superseded as follows:

(5) Check stator for shorts and leakage and for continuity (fig. 9-21). If evidence of shorts or leakage occurs or if continuity checks reveal stator is defective, replace stator.

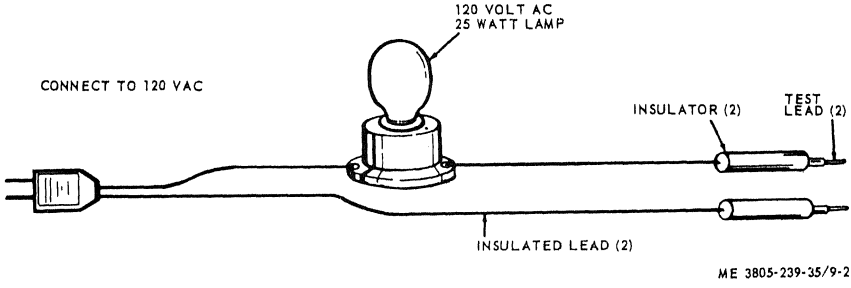


Figure 9-21. Stator test circuit.

Page 9-10. Paragraph 9-4o (1) is superseded as follows:

(1) Install diodes (31 and 32, fig. 9-16) and stator (35) on rear housing (36) with washers (30) and insulators (29). Secure diodes with nuts (28).

Page 9-10. After paragraph 9-4p, insert new Section III, as follows:

Section III. REVERSE POLARITY PROTECTOR

9-5. General

a. The reverse polarity protector consists of two major parts, (1) A diode-heat sink assembly and, (2) A solenoid switch.

b. This unit must be mounted in a vertical position with the heat sink above the solenoid switch. See figure 9-22.

9-6. Operation and Testing

a. The diode will allow positive battery potential to flow one way, from terminal D-1 to terminal D-2. Refer to figure 9-23.

b. Terminal S-1 of the solenoid is grounded to the mounting bolt. When positive energy is applied to S-2 terminal of the solenoid, the plunger in the solenoid will close the circuit between the load terminals L-1 and L-2.

c. Diode terminal D-2 and solenoid terminal S-2 are wired together. If the correct battery potential (positive) is applied to D-1, it will pass through the diode and energize the solenoid, connecting the battery at L-2 with the alternator at L-1.

d. If the reverse battery potential is applied to D-1, it will not pass through the diode in the heat sink, and not permit the solenoid to close, so that reverse battery energy cannot be connected to the alternator.

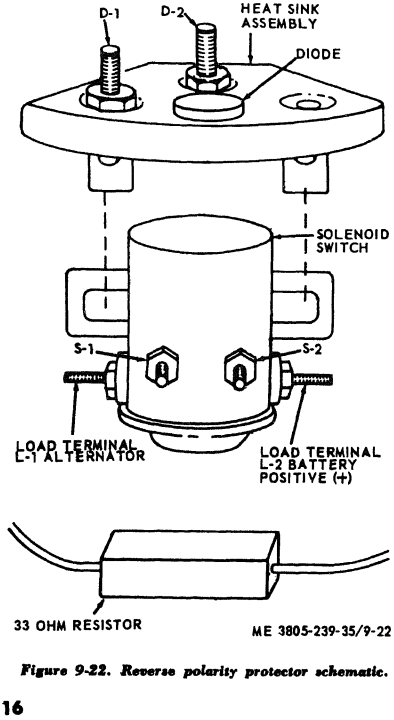


Figure 9-22. Reverse polarity protector schematic.

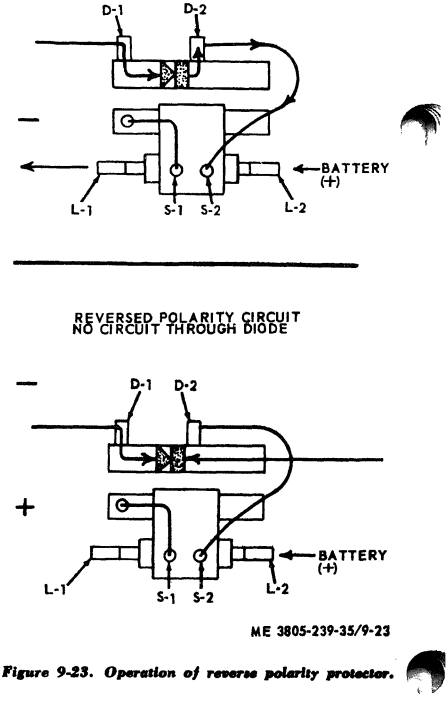
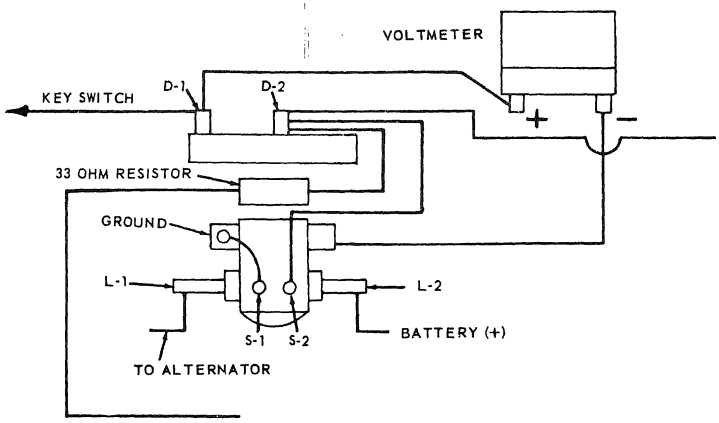


Figure 9-23. Operation of reverse polarity protector.



ME 3805-239-35/9-24

Figure 9-24. Testing reverse polarity protector.

e. Testing Reverse Polarity Protector (Switch on—Engine not running).

(1) Connect voltmeter as shown in figure 9-24.

(2) Turn key switch on, observe voltmeter readings as *positive* voltmeter lead is moved to each terminal (see table 9-2).

Table 9-2. Voltmeter Readings

Terminal	*Voltmeter Should Indicate*
D-1	Battery voltage, 24.0 to 26.2 volts. If no voltage is noted, check the key switch for poor connection, open circuit.
D-2	Approximately 1.0 volt less than battery voltage found in test D-1 above. No voltage indicates an open diode, replace reverse polarity protector and retest. A shorted diode will show the same voltage as D-1 above.
S-2	Same as for D-2 test.
L-1	Battery voltage as found in test D-1 above.
L-2	Battery voltage as found in test D-1 above. If no voltage, replace reverse polarity protector and retest.

(3) With key switch turned off, only terminal L-2 should indicate battery voltage.

NOTE

A shorted diode may keep the engine electrical solenoid on fuel pump to remain engaged after key switch is turned off. Replace reverse polarity protector.

Page 9-10. Section III is changed to read Section IV.

Page 9-10. Paragraph 9-5 is changed to read 9-7 and paragraph 9-6 is changed to read 9-8.

Page 9-11. Section IV is changed to read Section V.

Page 9-11. Paragraph 9-7 is changed to read 9-9 and paragraph 9-8 is changed to read 9-10.

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:

KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

Distribution:

To be distributed in accordance with DA Form 12-25, Sec II (qty rqr Block #403), Direct and General Support requirements for Earthmoving Equipment: Loaders.

TM 5-3805-239-35
C 2

CHANGE
No. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D. C. *2 October 1970*

DS, GS, and Depot Maintenance Manual LOADER SCOOP TYPE, PNEU-TIRED, DIESEL ENGINE DRIVEN, HINGED FRAME STEER, WITH 2½ CU YD MULTI-PURPOSE BUCKET (ALLIS CHALMERS MODEL 645M) FSN 3805-051-9359

TM 5-3805-239-35, 5 July 1968, is changed as follows:

Title is changed as shown above.

Page i. Chapter 1, Section I, under paragraph, change "1-1, 1-1" to read: "1-1, 1-2".
Chapter 5, Section V, change "Clam safety valve" to read: "Clam relief valve".
Page ii. Chapter 9, Section II, change "Generator" to read: "Alternator".
Chapter 10, Section II, change "Drive shafts" to read: "Propeller shafts".
Page 1-1. Paragraph 1-2*b* in line 1, change "all" to read: "of".
Page 2-5. So much of paragraph 2-20 that reads "generator" is changed to read: "alternator". (4 places).
Page 2-12. Paragraph 2-34*b* is superseded as follows:

b. Removal and Installation. Refer to TM 5-3805-239-12 for instructions on removal and installation of brake pedals and air application valve.

Subparagraph 2-34c is rescinded.
Page 2-14. Figure 2-10 is rescinded.
Page 3-7. Paragraph 3-5 is superseded as follows:

3-5. Fuel Tank

a. Removal.

(1) Refer to TM 5-3805-239-12, remove radiator grille, drain fuel tank, then remove fuel hose, tubes, shutoff valve, drain cock, and fittings.

(2) Remove eight nuts, eight flatwashers, eight screws, and eight flatwashers securing fuel tank to frame, then remove fuel tank.

b. Cleaning. Clean all parts in solvent (Spec. P-S-661) and dry thoroughly with compressed air.

c. Inspection and Repair.

(1) Inspect hose, tubes, and fittings for kinks, cracks, or other damage.

(2) Inspect hardware and threads of fuel hose or tubes for damage or defect.

(3) Inspect fuel tank for leaks or other damage.

(4) Repair by replacing damaged or defective parts.

d. Installation.

(1) Position fuel tank on rear frame section

ponents removed in *a* (1) above.

(3) After installation of fuel lines and fittings, vent the fuel system as necessary.

Page 3-24. Paragraph 3-7*i* (3). After line 2 add note as follows:

NOTE

When installing fuel injection pump, the timing pointer (fig. 3-9) and fuel injection pump timing marks (fig. 3-25) must be aligned. Timing marks on gear train (fig. 3-44) may not be aligned at this point, as they are meant for initial installation after teardown (see note on figure 3-44).

Page 3-29. Paragraph 3-14 is superseded as follows:

3-14. Oil Cooler

a. Removal.

(1) Refer to figure 3-28.1, disconnect water tube (1) and remove four packing (2). Remove water tube (1).

(2) Remove three screws (3), lockwashers (4), screw (7), lockwasher (6), two screws (5) and lockwashers (6), then remove oil cooler (9) and two packings (8) from engine.

b. Disassembly.

(1) Remove eight nuts (11), lockwashers (12), and screws (13). Remove eight nuts (16), lockwashers (17), seven screws (14), and screw (15), then remove headers (18 and 22), two gaskets (19), from oil coolers (20 and 21).

(2) Separate cooler (20) from (21) then remove packing (23).

dry thoroughly with compressed air:

WARNING

Fumes from this solvent are highly toxic and volatile. Use Only in well ventilated area. Do not breathe fumes for extended periods.

d. Inspection and Repair.

(1) Manufacture two suitable improvise cover plates, one with an air hose fitting. Use seal under plates and install plate with air hose fittin on oil inlet port, the other on the oil outlet. Secur with "C" clamps.

(2) Attach an air hose to the fitting. Submerg the oil cooler in hot water that will bring tempera ture of cooler to approximately 150°F., apply ai pressure of 200 psi, then test for leaks.

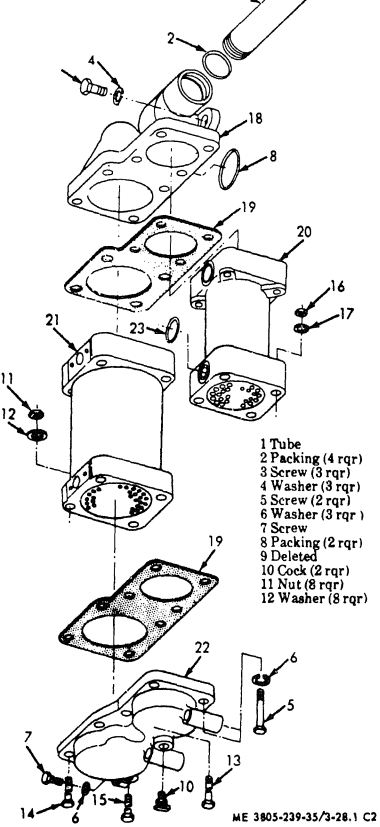
(3) Air bubbles observed at either open end o the oil cooler indicates the core is punctured. Whe housing leaks, see the instructions in (4) below.

(4) Repair by replacing an oil cooler wit ruptured core. Repair a leaking housing as direct ed in TM 9-2858. Replace damaged headers or de fective mounting hardware. When gaskets (19 fig. 3-28.1) are not reusable, replace the assembly.

e. Reassembly. Reassemble the oil cooler b reversing the procedure used in *b.* above.

f. Installation. Use new packings (8 and 23) a installation is performed by reversing the proce dures used in *a.* above.

Figure 3-28.1 is added after figure 3-28 as follows:



1 Tube
2 Packing (4 rqr)
3 Screw (3 rqr)
4 Washer (3 rqr)
5 Screw (2 rqr)
6 Washer (3 rqr)
7 Screw
8 Packing (2 rqr)
9 Deleted
10 Cock (2 rqr)
11 Nut (8 rqr)
12 Washer (8 rqr)
13 Screw (8 rqr)
14 Screw (7 rqr)
15 Screw
16 Nut (8 rqr)
17 Washer (8 rqr)
18 Header
19 Gasket (2 rqr)
20 Cooler
21 Cooler
22 Header
23 Packing

Figure 3-28.1 Oil cooler removal, disassembly, reassembly, and installation.

a. General. The oil pressure regulating valve, located in the main oil gallery adjacent to the fuel filter, maintains a stabilized pressure in the lubrication system. When pressure at the valve exceeds 50 psi, the piston is raised off its seat and allows oil to flow directly from engine block to the oil pan.

b. Removal.

(1) Clean external dirt and grime from area of the valve.

(2) Refer to figure 3-34.1 and remove the oil pressure regulating valve components from the engine block.

c. Cleaning. Clean all components in solvent (Spec. P-S-661) and dry thoroughly with compressed air.

d. Inspection and Repair.

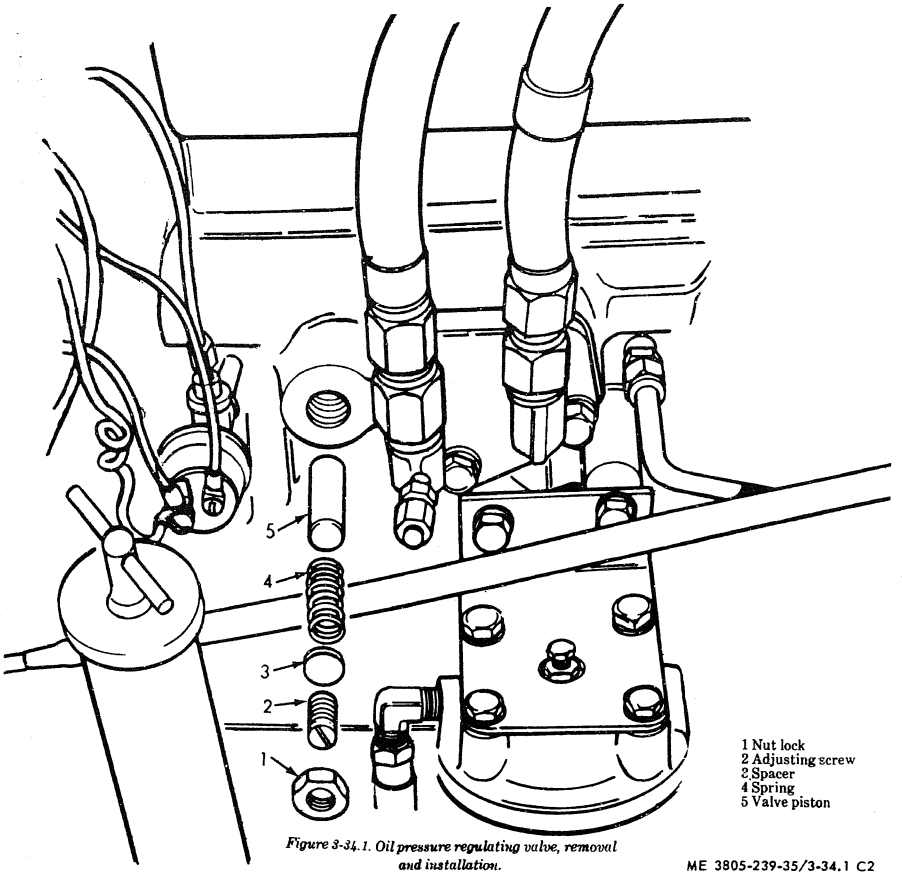
(1) Inspect spring for signs of fatigue or damage.

(2) Inspect piston for wear or scoring. The piston must move freely in valve bore.

(3) Inspect threads of adjusting screw for damage.

(4) Repair by replacing damaged or defective parts.

e. Installation. Install by reversing the procedures used for removal in *b.* above.



1 Nut lock
2 Adjusting screw
3 Spacer
4 Spring
5 Valve piston

Figure 3-34.1. Oil pressure regulating valve, removal and installation.

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Page 3-43. Paragraph 3-25 *a* (1) is superseded as follows:

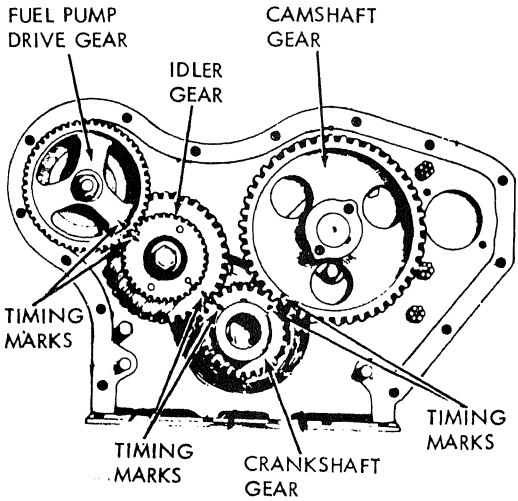
(1) Refer to TM 5-3805-239-12 and drain the cooling system; remove the radiator, water pump, alternator, and air compressor drive belts.

Page 3-44. Paragraph 3-25*d* (4) and (5) are superseded by (4) as follows:

(4) Refer to TM 5-3805-239-12 and install the air compressor drive belts, alternator, water pump, radiator, and fill the engine cooling system.

Page 3-46. Figure 3-44 is superseded as follows:

NOTE: THESE TIMING MARKS MAY NOT BE ALIGNED WHEN TIMING INJECTION PUMP TO 24° BTDC (REF PARA 3-7*i* (3). TIMING MARKS ON GEARS ARE FOR INITIAL INSTALLATION AFTER TEARDOWN.



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Figure 3-44. Gear train and timing marks.

Page 4-9. Paragraph 4-4*b* (1) is superseded as follows:

(1) Remove nut (1, fig. 4-2), washer (2), and yoke flange (3), then remove parking brake (4) (para 8-16).

Page 4-22. Paragraph 4-4*n* (26) is superseded as follows:

(26) Install parking brake (para 8-16).

Page 5-14. So much of Section V title, paragraphs 5-9, 5-10, and figure 5-9 title as reads "safety" is changed to read: "relief". (9 places).

Page 8-9. Paragraph 8-6*a* is superseded as follows:

a. Removal. Refer to TM 5-3805-239-12 and remove the air compressor governor.

Page 8-10. Paragraph 8-6*f* and *g* are superseded as follows:

f. Installation. Refer to TM 5-3805-239-12 and install the air compressor governor.

g. Adjustment. Refer to TM 5-3805-239-12 for air compressor governor adjustment instructions.

Paragraphs 8-7*b* is superseded as follows:

b. Removal. Refer to TM 5-3805-239-12 and remove tubes, hose, fittings and air reservoir from the loader.

Page 8-11 and 8-12. Paragraphs 8-7*d* and *e* are superseded as follows:

d. Inspection and Repair.

(1) Inspect condition of safety valve (31, fig. 8-7), transmitter (27), air supply valve (16), and the two check valves (39).

(2) Inspect reservoir for leakage, dents, or other damage. Check condition of internal threads.

(3) Repair by chasing burred internal threads, and welding leaking cracks. Replace damaged or defective reservoir, tubes, fittings, or valves.

e. Installation. Refer to TM 5-3805-239-12 and install air reservoir, fittings, hose and tubes on loader.

Page 8-12. Paragraph 8-8*b* is superseded as follows:

b. Removal. Refer to TM 5-3805-239-12 and remove safety valve from tee at end of reservoir.

Page 8-13. Paragraph 8-8*h* is superseded as follows:

h. Installation. Refer to TM 5-3805-239-12 and install safety valve in tee at end of air reservoir.

Paragraph 8-9*c* and *d* are superseded as follows:

c. Removal. Refer to TM 5-3805-239-12 and remove airline hose or tubes as required.

d. Installation. Refer to TM 5-3805-239-12 and install air line hose or tubes in reverse order of removal.

Paragraph 8-10*a*, in line 1, change "dual air application valve" to read: "dual air application (treadle) valve".

Paragraph 8-10*b* is superseded as follows:

b. Removal and Installation. Refer to TM 5-3805-239-12 for instructions on removal or installation of the brake pedals, rod, and air application treadle valve.

Page 8-14. Paragraph 8-10*f* (3) is superseded as follows:

(3) Install rod (7) between left pedal (10) and right pedal (9, fig. 8-10), then secure rod (7, fig. 8-9) to pedals with four capscrews, lockwashers, and nuts.

Paragraph 8-10*f* (4) is rescinded.

Page 8-19. Paragraph 8-12*g* (2) is superseded as follows:

(2) Connect hydraulic lines to wheel cylinders, then fill brake power clusters with hydraulic fluid.

Paragraph 8-12*h* is added after *g* as follows:

h. Adjustment. Refer to TM 5-3805-239-12 for instructions about check, bleeding, and adjusting wheel brakes.

Page 8-24. Paragraph 8-16*a* is superseded as follows:

a. Removal.

(1) Park the loader on a firm level surface. Block all wheels to prevent loader from moving.

(2) Refer to TM 5-3805-239-12 and remove parking brake linkage.

(3) Remove nut (1, fig. 4-2), washer (2), flange yoke (3), and brake drum (2, fig. 8-16) from output shaft (12, fig. 4-2).

Paragraph 8-16*f* is superseded as follows:

f. Installation.

(1) Install flange yoke (3, fig. 4-2) as described in paragraph 4-4*n* (28).

(2) Install parking brake linkage (TM 5-3805-239-12), then remove blocks from in front or back of loader wheels.

Page 9-8. Paragraph 9-4*k*, line 2 change "generator" to read: "alternator"

Page 9-11. Paragraph 9-10*b* (4), in line 3 change "generator" to read: "alternator".

Page 10-1. Paragraph 10-1*b*, in lines 1 and 7 change "Drive shafts" to read: "Propeller shafts".

Section II title, change "DRIVE" to read "PROPELLER."

Paragraph 10-3 is superseded as follows:

10-3. Rear Propeller Shaft

a. Removal. Refer to TM 5-3805-239-12 and remove the rear propeller shaft (fig. 10-1) from the loader.

b. Disassembly.

(1) Remove screws (1, fig. 10-2), lock plates (2), and cover plates (3), then remove cross assemblies (4) from propeller shaft. Remove lubrication fittings (10) from cross (4).

NOTE

The cross assemblies may have been left attached to yoke of transmission and differential when the rear propeller shaft was removed from the loader.

(2) Loosen packing retainer nut (5), separate slip yoke (8) and tube yoke (9), then remove nut (5) washer (6) and felt washer (7).

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts with solvent (Spec. P-S-661) and dry thoroughly with compressed air.

(2) Inspect cross assemblies for excessive wear or other damage. Inspect retainer nut and washers for damage or deterioration. Inspect yokes for cracks, thread damage, and damage to external or internal splines.

(3) Repair by replacing damaged or defective parts.

d. Reassembly.

(1) Coat splines of slip yoke (8, fig. 10-2) liberally with grease (GAA), then slip retainer nut (5), washer (6) and felt washer (7) over splines in that order.

nsert external splines of slip yoke into engagement ith the internal splines of tube yoke, then slide ip yoke fully into tube yoke. Move slip yoke in and ut several times to assure smooth operation, then ighten retainer nut on threads of tube yoke.

(2) Install lubrication fittings (10) in cross assemblies (4), install cross assemblies in yoke, and ecure with two cover plates (3), lockplates (2), and four screws (1).

NOTE

Remaining plates and screws will be installed as the rear propeller shaft is installed on loader.

e. Installation. Refer to TM 5-3805-239-12 and install the rear propeller shaft on loader.

Page 10-2. Figure 10-1 is superseded as follows:

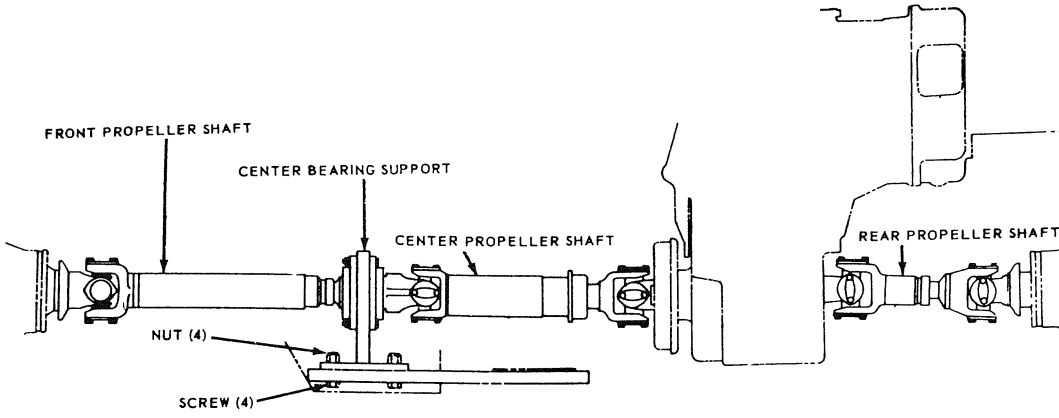


Figure 10-1. Propeller shafts and center bearing support.

Paragraph 10-4 is superseded as follows:

10-4. Center Propeller Shaft

a. Removal. Refer to TM 5-3805-239-12 and remove center propeller shaft (2, fig. 10-1) from the loader.

b. Disassembly.

(1) Remove screws (1, fig. 10-3), lock plates (2), cover plates (3), and cross assemblies (5) from yokes. Remove lubrication fittings (4) from cross assemblies (5).

NOTE

The cross assemblies may have been left attached to yoke of transmission and center bearing support when the center propeller shaft was removed from the loader.

(2) Remove retaining ring (6) from its groove in tube yoke (14), then using care not to drop balls (11) and springs (10) from their grooves, withdraw shaft yoke (12), ring (6), washer (7), seal (8) and thrust washer (9) from tube yoke (14).

(3) Remove balls (11), spring (10), thrust washer (9), seal (8), washer (7), and retaining ring (6) from splines of shaft yoke (12). Remove lubrication fitting (13) from tube yoke (14).

c. Cleaning, Inspection and Repair.

(1) Clean all metal parts in solvent (Spec. P-S-661) and dry thoroughly with compressed air.

(2) Inspect cross assemblies for excessive wear or other damage. Inspect springs and test for uniform tension or other damage. Inspect thrust washer and brass washer for wear or other damage.

(3) Inspect balls for excessive wear or flat spots. Inspect their grooves in shaft yoke for damage or wear. Inspect yokes for cracks or other damage.

(4) Repair by replacing worn, damaged, or defective components.

d. Reassembly.

(1) Position thrust washer (9, fig. 10-3), seal (8) washer (7), and retaining ring (6) on shaft Yoke (12).

(2) Install lubrication fitting (13) in tube yoke (14).

(3) Coat interior of tube yoke (14) and exterior of shaft yoke (12) liberally with grease (GAA). Position splines of shaft yoke (12) partially into tube yoke (14).

(4) Position springs (10) and balls (11) in grooves of shaft yoke, then slide shaft yoke fully into tube yoke.

(5) Compress springs with thrust washer (9), seal (8), and washer (7), then install retaining ring (6) in its groove in tube yoke.

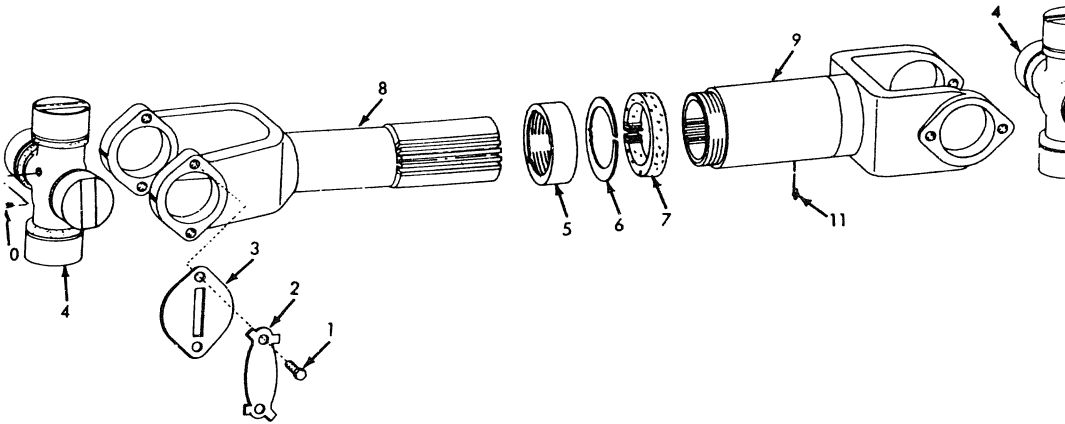
(6) Install lubrication fittings (4) in cross assemblies (5), then insert cross assemblies in yokes and secure with cover plates (3), lock plates (2), and screws (1).

NOTE

Remaining plates and screws will be installed as the center propeller shaft is installed on loader.

e. Installation. Refer to TM 5-3805-239-12 and install the center propeller shaft on loader.

Page 10-3. Figure 10-2 is superseded as follows:



1. SCREW, CAP, HEX-HEAD, 5/16-24 X 1/2 IN. (16 RQR)
2. LOCK PLATE (8 RQR)
3. COVER PLATE (8 RQR)
4. CROSS ASSEMBLY (2 RQR)
5. NUT, RETAINER PACKING
6. WASHER
7. WASHER, FELT
8. YOKE, SLIP
9. YOKE, TUBE
10. LUBRICATION FITTING (2 RQR)
11. LUBRICATION FITTING

Paragraph 10-5 is superseded as follows:

10-5. Front Propeller Shaft

a. Removal.

(1) Refer to TM 5-3805-239-12 and remove the forward portion of the front propeller shaft from the loader.

(2) Refer to paragraph 10-6 and remove the yoke (3, fig. 10-5) and splined shaft (8) portion of the front propeller shaft.

b. Disassembly.

(1) Remove screws (1, fig. 10-4), lock plates (2), cover plates (3), and cross assembly (5) from tube yoke (10). Remove lubrication fitting (4) from cross (5).

(2) Remove packing retainer dust cap (6), washer (7), and felt washer (8) from tube yoke (10), then remove plug (9).

c. Cleaning, Inspection and Repair.

(1) Clean all metal parts in solvent (Spec. P-S-661) and dry thoroughly with compressed air.

(2) Inspect cross assembly for wear or other damage. Inspect packing retainer dust cap, and washers for damage or deterioration. Inspect interval splines and threads of tube yoke for damage or cracks in yoke, then inspect external splines of shaft, and the bearing surface ofr wear or other damage.

(3) Repair by replacing damaged or defective components.

d. Reassembly.

(1) Install plug (9, fig. 10-4) in tube yoke (10).

(2) Position felt washer (8), washer (7), and packing retainer dust cap (6) on tube yoke (10). Start dust cap threads on yoke but do not tighten.

(3) Install lubrication fitting (4) in cross assembly (5). Position cross assembly in yoke and secure with two cover plates (3), lockplates (2) and screws (1).

NOTE

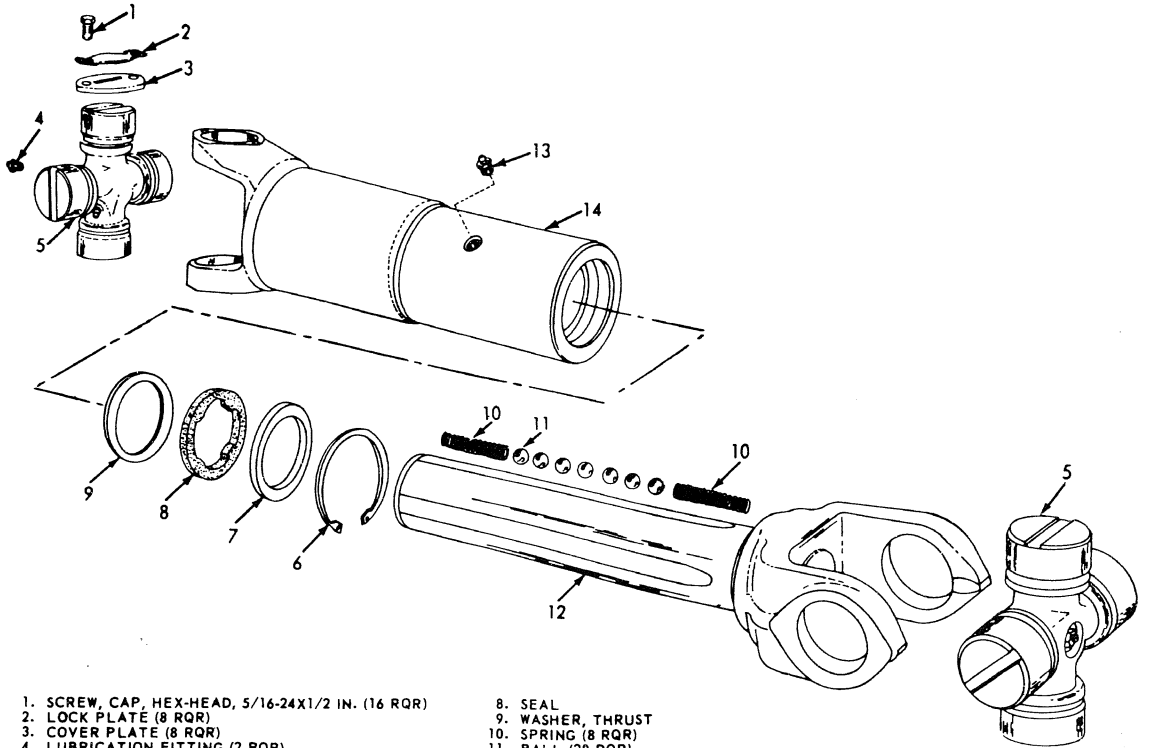
Remaining plates will be installed when front propeller shaft is installed on the loader.

e. Installation.

(1) Refer to paragraph 10-6 and install shaft 8, fig. 10-5) in center bearing support, tnen install yoke (3).

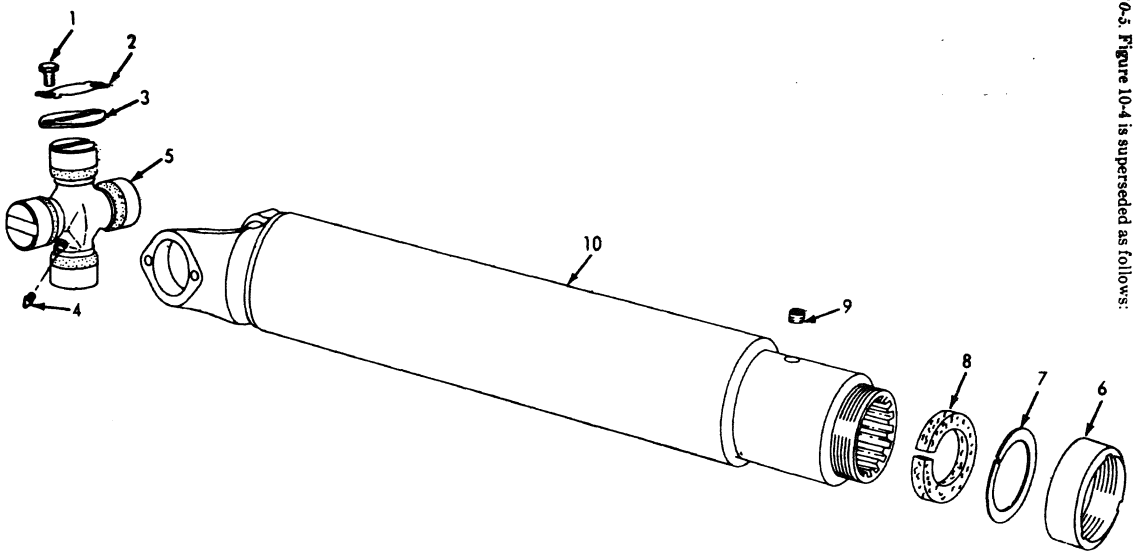
(2) Refer to TM 5-3805-239-12 and install the forward portion of the front propeller shaft.

Page 10-4. Figure 10-3 is superseded as follows:



1. SCREW, CAP, HEX-HEAD, 5/16-24X1/2 IN. (16 RQR)
2. LOCK PLATE (8 RQR)
3. COVER PLATE (8 RQR)
4. LUBRICATION FITTING (2 RQR)
5. CROSS ASSEMBLY, SHAFT (2 RQR)
6. RING, RETAINING
7. WASHER, BRASS
8. SEAL
9. WASHER, THRUST
10. SPRING (8 RQR)
11. BALL (28 RQR)
12. YOKE, SHAFT
13. LUBRICATION FITTING (2 RQR)
14. YOKE, TUBE ASSEMBLY

Figure 10-3. Center propeller shaft, exploded view.



1. SCREW, CAP, HEX-HEAD, 5/16-24 X 1/2 IN. (8 RQR)
2. LOCK PLATE (4 RQR)
3. COVER PLATE (4 RQR)
4. LUBRICATION FITTING
5. CROSS ASSEMBLY, SHAFT
6. DUST CAP, PACKING RETAINER
7. WASHER
8. WASHER, FELT
9. PLUG
10. YOKE, TUBE ASSEMBLY

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Figure 10-4. Front propeller shaft (forward portion), exploded view.

Paragraph 10-6 is superseded as follows:

10-6. Center Bearing Support

a. Removal.

(1) Refer to TM 5-3805-239-12 and disconnect or remove the forward portion of front propeller shaft, and the center propeller shaft from the shaft (8, fig. 10-5) in center bearing support.

(2) Remove four nuts (4, fig. 10-1) and screws (5), then remove center bearing support from the loader.

b. Disassembly.

(1) Remove selflocking nut (1, fig. 10-5) and washer (2) from shaft (8). Use a suitable puller and remove yoke (3) from shafts (8).

(2) Remove six nuts (5), screws (4), and two covers (6) from bracket (10).

(3) Tap shaft (8) gently with a soft hammer to remove shaft from bearing (9) in bracket (10).

(4) Use a suitable press and remove bearing (9) from bracket (10).

(5) Do not remove oil seals (7) from covers (6) unless replacement is required. Remove seals by prying them out of the covers.

c. Cleaning, Inspection and Repair.

(1) Clean all metal parts in solvent (spec. P-S-661) and dry thoroughly with compressed air.

(2) Inspect yoke and shaft as described in paragraph 10-5.

(3) Inspect bearing for excessive wear or other damage. Oil the bearing and rotate. It must rotate freely without binding. Repack a serviceable bearing with grease (GAA), then wrap with cloth or paper and lay aside until reassembly.

(4) Ispect covers for crack or other damage. Inspect surface of oil seals for damage or deterioration.

(5) Inspect bearing surface in bore of bracket for wear, scoring or other damage, and mounting flange for cracks.

(6) Repair by replacing damaged or defective components.

d. Reassembly.

(1) Use a suitable installation device to install oils seals (7, fig. 10-5) into covers (6).

(2) Press bearing (9) into bore of bracket (10). Press shaft (8) into bearing (9) until bearing is equally spaced on bearing surface of shaft.

(3) Position covers (6) over ends of shaft (8) and secure them to bracket (10) with six screws (4) and selflocking nuts (5).

(4) Press yoke (3) on shaft splines at threaded end and secure with washer (2), and selflocking nut (1).

e. Installation.

(1) Position center bearing support (6, fig. 10-1) on loader frame and secure with four screws (5), and nuts (4). Tighten nuts to a torque of between 200-220 ft-lb.

(2) Refer to TM 5-3805-239-12 and connect forward portion of front propeller shaft and the center propeller shaft to shaft and yoke in center bearing support.

Page 10-6. Figure 10-5 title, change "Bearing and support" to read: "Center bearing support".

Page 10-7. Figure 10-6 *title is added* as follows:

Figure 10-6. Platform, floor, and cowl, removal and installation.

Page 10-8. Figure 10-7 *title is added* as follows:

Figure 10-7. Front and rear frame sections, removal and installation.

Page 10-9. Paragraph 10-8 title. Change "Platform" to read: "Platform and Cowl".

Paragraph 10-8*a* (3) in line 1, change "paragraph 2-34" to read: "TM 5-3805-239-12".

Page A-1. Appendix A is superseded as follows:

APPENDIX A
REFERENCES

A-1. Fire Protection

TB 5-4200-200-10	Hand Portable Fire Extinguishers for Army Users.

A-2. Lubrication

C9100IL	Fuels, Lubricants, Oils and Waxes
LO 5-3805-239-12-1	Lubrication Order, Loader, Scoop type, pneumatic-tired, D.E.D. hinged frame steer with 2½ cubic yard multipurpose bucket (Allis-Chalmers Model 645M) W/ Allis-Chalmers engine Model 3500
LO 5-3805-239-12-2	

A-3. Painting

TM 9-213	Painting Instructions for Field Use

A-4. Radio Suppression

TM 11-483	Radio Interference Suppression

A-5. Maintenance

TM 9-1870-1	Care and Maintenance of Pneumatic Tires
TB 750-651	Use of Anti-freeze Solutions and cleaning compounds in engine cooling systems
TM 38-750	The Army Maintenance Management System (TAMMS)
TM 5-3805-239-12	Operator and Organizational Maintenance Manual, Loader Scoop Type, Pneu-Tired, Diesel Engine Driven, Hinged Frame Steer, with 2½ Cu Yd Multi-Purpose Bucket, Allis-Chalmers Model 645M, FSN 3805-051-9359
TM 5-3805-239-35P	Direct and General Support and Depot Maintenance Repair Parts and Special Tools Lists, Loader Scoop-Type, Pneu-Tired, Diesel Engine Driven, Hinged Frame Steer, With 2½ Cu Yd Multi-Purpose Bucket, Allis-Chalmers Model 645M FSN 3805-051-9359
TM 9-6140-200-15	Operation and Organizational Field and Depot Maintenance Storage Batteries, Lead Acid Type
TM 5-764	Electric Motor and Generator Repair
TM 9-2858	Cooling Systems; Vehicles and Powered Ground Equipment

A-6. Shipment and Storage

TB 740-93-2	Preservation of USAMEC Mechanical Equipment for Shipment and Storage

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:

KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

Distribution:

To be distributed in accordance with DA Form 12-25, Sec II (qty rqr Block #403), Direct/General Support requirements for Earthmoving Equipment: Loaders.

TM 5-3805-239-35
C 3

Change No. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C. *24 January 1974*

Direct and General Support and Depot Maintenance Manual LOADER, SCOOP-TYPE; PNEUMATIC TIRED; DIESEL ENGINE DRIVEN; HINGED-FRAME STEER; WITH 2 1/2 CU.YD. MULTI-PURPOSE BUCKET (ALLIS-CHALMERS MODEL 645M) FSN 3805-051-9359

TM 5-3805-239-35, 5 July 1968 is changed as follows:

Page 1-1, paragraph 1-1*b*. The mailing address is changed to read: "Commander, U.S. Army Troop Support Command, ATTN: AMSTS-MPP, St. Louis, MO 63120.

Page 1-2. Figure 1-1 is superseded:

Page 1-3. Legend for figure 1-1, item 21 is changed to read "Alternator".

Page 6-7. Paragraph 6-4*h* is added:

h. Test. (Steering). Refer to TM 5-3805-239-12, C6 and perform test procedures on steering hydraulic system.

Page 6-9. Paragraph 6-5.*h* is added:

h. Test. (Main hydraulic system). Refer to TM 5-3805-239-12, C 6 and perform test procedures on the main hydraulic system.

Page 8-10. Paragraph 8-7.*a*. The last sentence is changed to read: "A transmitter, mounted on the reservoir, actuates the warning buzzer and light when the pressure drops below 55 PSI".

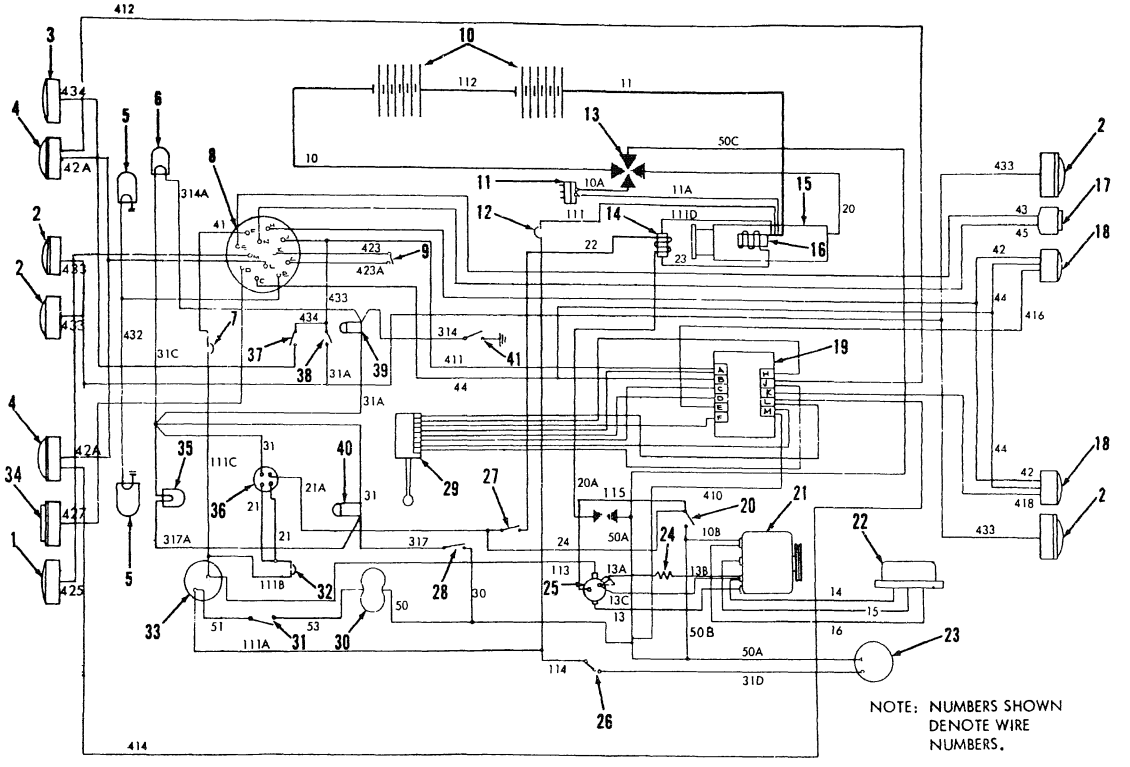


Figure 1-1. Schematic wiring diagram

By Order of the Secretary of the Army:

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General, United States Army
Chief of Staff

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Major General, United States Army
The Adjutant General

Distribution:
To be distributed in accordance with DA Form 12-25B, (qty rqr block No. 403) Direct and General Support maintenance requirements for Loaders, Earth Moving Equipment.

TECHNICAL MANUAL
No. 5-3805-239-35

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *5 July 1968*

DIRECT AND GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

LOADER SCOOP TYPE, PNEU TIRED, DIESEL ENGINE DRIVEN, HINGED FRAME STEER, WITH 2½ CU YD MULTI-PURPOSE BUCKET, ALLIS CHALMERS MODEL 645M FSN 3805-051-9359

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1–1. Scope

a. These instructions are published for use of direct and general support and depot maintenance personnel maintaining the Allis-Chalmers Model 645M scoop-type loader. They provide information on the maintenance of equipment which is beyond the scope of the tools, equipment, personnel, or supplies normally available to the using organizations.

b. Report of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on a DA Form 2028 (Recommended Changes to DA Publications) and forwarded direct to Commanding General, U.S. Army Mobility Equipment Command, ATTN: AMSME-MPP, 4300 Goodfellow Boulevard, St. Louis, Mo. 63120.

c. Report all equipment improvement recommendations as prescribed by TM 38–750.

1–2. Record and Report Forms

For record and report forms applicable to direct and general support and depot maintenance, refer to TM 38–750.

Note. Applicable forms, excluding Standard Form 46 (United States Government Motor Vehicles Operator's Identification Card) which is carried by the operator, shall be kept in a canvas bag mounted on the equipment.

Section II. DESCRIPTION AND TABULATED DATA

1–3. Description

A general description of the loader, the location and description of identification and instruction plates, and the information on the differences in models are contained in the Operator and Organizational Maintenance manual. Direct and general support and depot repair and maintenance instructions are described in appropriate sections of this manual.

1–4. Tabulated Data

a. General. This paragraph contains all overhaul data pertinent to direct and general support and depot maintenance personnel. A wiring diagram (fig. 1–1) is included.

b. Nut and Bolt Torque Data.

Note. The following listing shows major nut and bolt torques for the loader and engine. The torques are all listed in ft-lb (foot-pounds) except where otherwise noted. All torque values are calculated for threads lubricated with oil.

(1) *Engine.*

Item	*Torque (foot-pounds)*
Cylinder head screws	130–140
Main bearing cap screws	170–190
Connecting rod cap screws	65–70
Rocker cover screws	3–4
Fuel injection pump shaft retaining nut	35–40
Fuel injection nozzle nut	40–60
Fuel injection nozzle cap lock nut	75–90
Nozzle holder cap nut	75–90
Rocker arm shaft plug	40
Water pump mounting screws	18–21
Generator mounting screws	18–21
Starter mounting screws	13–17
Oil pan screws	28–33
Oil pump cover screws	9–11
Oil pump mounting screws	44–49
Rocker arm mounting screws	130–140
Rocker arm center screw	28–33
Crankshaft pulley screw	220
Timing gear cover screws	28–33
Injection pump adapter screws	18–21
Idler gear screw	95–105
Camshaft thrust plate screws	18–20

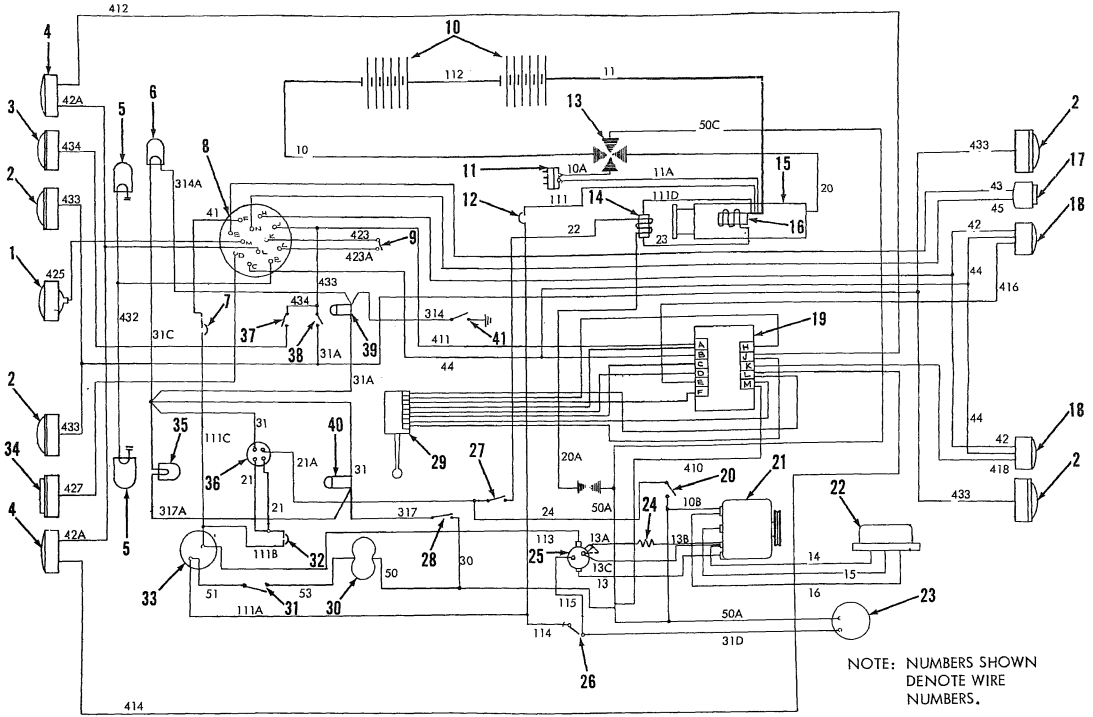


Figure 1-1. Schematic wiring diagram.

1 Headlight
2 Floodlight (4)
3 Auxiliary floodlight
4 Parking and directional light (2)
5 Panel light (2)
6 Converter temperature warning light
7 Circuit breaker
8 Light switch
9 Stop light switch
10 Battery (2)
11 Slave receptacle
12 Circuit breaker
13 Ground
14 Auxiliary starter solenoid
15 Starting motor
16 Starter solenoid
17 Blackout stop and taillight
18 Stop and taillight (2)
19 Terminal board
20 Fuel shut-off
21 Generator (alternator)
22 Voltage regulator
23 Hourmeter
24 150 ohm resistor
25 Polarity protector
26 Oil pressure transmitter
27 Neutral start switch
28 Air pressure transmitter
29 Directional light switch
30 Horn
31 Horn button
32 Circuit breaker
33 Ammeter
34 Blackout headlight
35 Air pressure warning light
36 Master switch
37 Auxiliary floodlight switch
38 Floodlight switch
39 Converter temperature warning buzzer
40 Air pressure warning buzzer
41 Converter temperature transmitter

Figure 1-1—Continued.

(2) *Turbocharger.*

Item	Torque (foot-pounds)
Turbocharger mounting nuts	18–21
Turbine housing clamp nut	5–10 (in.-lb.)
Turbocharger housing screws	80–100 (in.-lb.)
Turbocharger impeller nut	80–100 (in.-lb.)
Turbocharger diffuser to housing screws	28–33
Turbocharger bearing housing plug	140–200 (in.-lb.)

(3) *Transmission.*

Item	Torque (foot-pounds)
Converter pump cover nuts	17–20
Converter pump mounting screws	17–20
Converter mounting screws	42–50
Oil charging pump screws	26–32
Planetary cover screws	36–43
High range clutch piston housing screws	83–100
Front cover screws	26–32
Yoke shaft nuts	600–800
Parking brake mounting screws	81–97
Front yoke flange screws	41–49
Engine flywheel to flex plate screws	41–49
Mounting bracket screws	120–130
Filter center screw	25–30
Engine to bell housing screws	30–35

(4) *Hydraulic cylinders.*

Item	Torque (foot-pounds)
Cylinder piston lock nuts	1400–1500
Lift cylinder head	1400–1500
Dump cylinder head	1400–1600

(5) *Front axle.*

Item	Torque (foot-pounds)
Axle anchor pin nuts	900–950
Carrier to housing nuts	92–103
Pinion cage screws	116–129
Differential case screws	130–145
Pinion shaft nut	700–900
Differential bearing adjusting nut	15–17
Adjusting nut lock nut	82–91
Differential bearing cap screws	290–320
Planetary spider cover screws	52–58
Planetary ring gear lock screws	33–37
Brake drum to hub screws	160–180
Brake camshaft collar screws	82–91
Planetary spider to hub screws	82–91

(6) *Rear axle.*

Item	Torque (foot-pounds)
Axle anchor pin nuts	900–950
Axle support pin nuts	1325–1375
Carrier to housing nuts	92–103
Pinion cage screws	116–129
Differential case screws	130–145
Pinion shaft nut	700–900
Differential bearing adjusting nut	15–17
Adjusting nut lock nut	82–91
Differential bearing cap screws	160–180
Planetary spider cover screws	52–58
Planetary ring gear lock screws	22–24
Brake drum to hub screws	160–180
Brake camshaft collar screws	82–91
Planetary spider to hub screws	82–91

(7) *Steering system.*

Item	Torque (foot-pounds)
Steering gear cover screws	25–35
Valve adapter screws	25–35
Seal assembly screws	17–23
Steering pump cover screws	35–40
Mast jacket screws	17–23
Steering thrust bearing nut	20–30
Lash adjustment lock nut	25–35
Housing plug	15–25
Hose fittings	20–30

(8) *Frame components.*

Item	Foot-pounds
Frame pivot pin nuts	2000
Pivot flange to front section nut	55–60
Drive shaft universal joint yoke nut	340–360
Universal joint base screws	200–220

(9) *Fuel injection pump.*

Item	Inch-pounds
Head locating screw	300
Fuel line connection screw	420
Head locking screw	300
Timing line cover screws	15–20
End plate plug	30
Delivery valve retaining screw	85–90
Advance screw hole plug	40–50
Piston hole plug	240
End plate screws	25–30
Pivot shaft nut	20–25

(10) *Standard screw torques (foot-pounds).*

Size	Grade 2	Grade 5	Grade 8
1/4–20	5–7	9–11	12–14
1/4–28	6–8	11–13	14–16
5/16–18	11–13	18–20	45–27
5/16–24	13–15	21–23	28–30
3/8–16	18–21	28–33	41–46
3/8–24	19–22	3–35	48–48
7/16–14	30–33	44–49	69–74
7/16–20	32–35	50–55	72–7[illegible]
1/2–13	45–50	68–73	95–1[illegible]
1/2–20	45–50	68–73	95–105
9/16–12	60–65	95–105	130–140
9/16–18	60–65	95–105	130–140
5/8–11	75–85	125–135	170–190
5/8–18	75–85	125–135	170–190
3/4–10	125–135	210–230	290–310
3/4–16	125–135	210–230	290–310
7/8–9	105–115	290–310	450–500
7/8–14	105–115	290–310	450–500
1–8	140–150	380–410	600–630
1–14	450–475		

(11) *Engine stud torques.*

Item	Torque (foot-pounds)
Injector nozzle mounting studs	7–22
Injection pump to adapter studs	10–35

c. Repair and Replacement Standards. Table 1–1 lists manufacturers sizes, tolerances, desired clearances, and maximum wear and clearances.

d. Schematic Wiring Diagram. Figure 1–1 shows the schematic wiring diagram for the loader.

Table 1–1. Repair and Replacement Standards

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
ENGINE:					
Cylinder block					
Bore diameter					
Top	4.8135	4.8155			
Bottom	4.7520	4.7540			
Counterbore diameter for sleeve flange	5.0060	5.0110			
Depth of counterbore	0.3150	0.3165			
Camshaft bearing bore diameter	2.2590	2.2600			
Main bearing bore, w/o bearing	3.5607	3.5614			
Valve lifter bore diameter	0.7495	0.7505			
Cylinder sleeve					
Outside diameter					
Below flange	4.811	4.813			
Packing ring location	4.7490	4.7510			
Cylinder sleeve					
Inside diameter	4.2495	4.2510			
Flange diameter	4.9980	5.0020			
Clearance w/bore					
At lower diameter	----------	----------	0.0010	0.0050	
Below flange	----------	----------	0.0005	0.0045	
Clearance w/piston skirt	----------	----------	0.0065	0.0090	
Allowable taper	----------	0.0015			
Allowable out-of-round (when installed)	----------	0.0015			
Height of fire wall above sleeve flange	0.0445	0.0475			
Height of sleeve flange above block	0.0020	0.0050			
Crankshaft					
Connecting rod journals diameter	2.7475	2.7485	--------	--------	0.0400
Main bearing journal diameter	3.2470	3.2480	--------	--------	0.0400

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
ENGINE:—Continued					
Width between connecting rod cheeks	1.5620	1.5650			
Main bearing journal width					
Front	2.1470	2.1670			
Intermediates	1.6850	1.6890			
Center	2.0610	2.0630			
Rear	2.0140	2.0170			
Crankshaft					
End clearence	0.0070	0.0130			
Fit of crankshaft gear on crankshaft	0.0010T	0.0030T			
Main bearings					
Inside diameter	3.2499	3.2516			
Bearing to journal clearance				0.0019	0.0046
Bearing thickness	0.1549	0.1554			
Length of bearings					
Front and intermediate	1.4320	1.4420			
Center and rear	1.6820	1.6920			
Pistons					
Diameter					
Between top and second ring groove	4.2180	4.2220			
Bottom of skirt at 90 from piston pin	4.2420	4.2430			
Piston pin bore diameter	1.5014	1.5016			
Length					
Piston	5.8240	5.8290			
Center of piston pin to top of piston	1.5027	1.5032			
Piston pins					
Length	3.6010	3.6160			
Piston pins					
Diameter	1.5015	1.5017			
Fit in bore	0.0001L	0.0003T			
Clearance in connecting rod bearing			0.0010	0.0017	
Piston rings					
Gap					
1st ring (chrome compression)	0.0190	0.0340			
2nd and 3rd ring (compression)	0.0150	0.0300			
4th ring (oil)	0.0130	0.0580			
Clearance in grooves					
1st ring			0.0065	0.0080	
2nd and 3rd rings			0.0030	0.0050	
4th ring			0.0025	0.0085	
Connecting rods					
Length-center to center	8.4980	8.5020			
Piston pin bearing					
Inside diameter	1.5027	1.5032			
Length	1.4900	1.5100			
Bearing bore (pin bearing)	1.6250	1.6255			
Bearing bore (crankshaft) bearing)	2.9700	2.9705			
Bearing to crankshaft journal clearance			0.0010	0.0035	
Rod width at lower end	1.5550	1.5570			
Side clearance-to-crankshaft journal			0.0050	0.0100	
Connecting rods					
Bearing (crankshaft)					
Inside diameter	2.7495	2.7510			
Length	1.1950	1.2050			
Thickness	0.10975	0.11025			
Exhaust valves					
Valve lift, w/0.015 lash		0.4125			

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
ENGINE:—Continued					
Valve lift, at cam		0.2850			
Seat angle		45°			
Seat contact width		0.09375			
Valve clearance (cold)		0.0180			
Valve clearance (hot)		0.0150			
Stem to guide clearance			0.0020	0.0025	
Head diameter	1.6770	1.6870			
Length		6.017			
Stem diameter	0.3705	0.3710			
Depth recessed in head	0.0530				
Exhaust valve seat insert					
Seat angle		45°			
Seat contact width		0.09375			
Seat runout		0.0020			
Press fit	0.0010	0.0030			
Insert outside diameter	1.6670	1.6680			
Valve guides					
Length		2.8750			
Inside diameter	0.3735	0.3740			
Guide extension from bottom of cylinder head					
Exhaust		1.09375			
Intake		0.78125			
Intake valves					
Valve lift (at valve)		0.4620			
Valve lift (at cam)		0.3180			
Seat angle		30°			
Seat contact width		0.9375			
Valve clearance (cold		0.0180			
Valve clearance (hot)		0.0150			
Valve diameter	1.8340	1.8440			
Length overall		6.0660			
Stem diameter	0.3715	0.3720			
Stem to guide clearance			0.0010	0.0015	
Valve depth in head	0.0540				
Valve springs					
Free length		2.53125			
Length (valve closed)	2.2370	2.2370			
Length (valve open)	1.7800	1.7800			
Spring load (valve closed)	38.00 lb	48.30 lb			
Spring load (valve open)	99.75 lb	120.75 lb			
Rocker arms					
Inside diameter	1.0010	1.0020			
Shaft diameter	0.9990	1.0000			
Shaft clearance in arm			0.0010	0.0030	
Camshaft					
Bearings					
Inside diameter	2.1330	2.1360			
Outside diameter	2.2630	2.2650			
Width of bearings					
Front		1.3750			
Intermediate and rear		1.0000			
Bearing fit in block	0.0030T	0.0060T			
Camshaft journals					
Outside diameter	2.1300	2.1310			
Bearing to journal clearance			0.0020	0.0060	
Camshaft end play	0.0030	0.0090			

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
ENGINE:—Continued					
Camshaft gear					
Width	----------	1.0000			
Fit on camshaft	0.0015T	0.0030T			
Thrust collar					
Thickness	0.2050	0.2060			
Valve lifter					
Outside diameter	0.7480	0.7485			
Fit in block	0.0010T	0.0025T			
Cylinder head					
Valve seat insert bore diameter	1.6650	1.6660			
Depth of insert counterbore	0.4735	0.4755			
Gear backlash					
Crankshaft gear to camshaft gear	0.0015	0.0090			
Crankshaft gear to idle gear	0.0015	0.0085			
Fuel pump drive gear to fuel pump driven gear.	0.0020	0.0095			
Oil pump					
Gear clearance					
To pump body	----------	----------	0.00075	0.00175	
End clearance	----------	----------	0.0020	0.0045	
Pump body					
Drive shaft bearing inside diameter	0.6240	0.6250			
Drive shaft					
Outside diameter					
At cover bearing	0.6170	0.6175			
At body bearing	0.6220	0.6225			
Drive shaft clearance in pump cover bearing	----------	----------	0.0020	0.0035	
Drive shaft clearance in pump upper body	----------	----------	0.0015	0.0030	
Pump cover					
Drive shaft bearing inside diameter	0.6195	0.6205			
Idler shaft bearing inside diameter	0.6185	0.6195			
Idler gear shaft					
Outside diameter	0.6180	0.6185			
Fit of idler gear shaft in cover	0.0000	0.0015L			
Pump cover					
Idler gear shaft bearing inside diameter	0.6160	0.6170			
Fit of idler gear shaft in cover	0.0010T	0.0025T			
Idler gear					
Bearing bore inside diameter	0.6190	0.6210			
Clearance of gear shaft in bearing	----------	----------	0.0005	0.0030	
Pump body bearing bore inside diameter	1.0000	1.0005			
Bearing					
Outside diameter	1.0015	1.0020			
Fit of bearing in body	0.0010T	0.0020T			
Inside diameter	0.6235	0.6255			
Clearance of shaft in bearing	----------	----------	0.0010	0.0035	
Drive gear					
Inside diameter	0.6205	0.6215			
Fit of shaft in gear	0.0005T	0.0020T			
Water pump					
Impeller clearance to plate	----------	----------	----------	0.0150	
Bearing					
Outside diameter	1.4495	1.5000			
Pump body					
Bearing bore inside diameter	1.4980	1.4990			
Fit of bearing in body	0.0005T	0.0010T			

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
ENGINE:—Continued					
Impeller					
Bore inside diameter	0.6225	0.6235			
Shaft outside diameter	0.6225	0.6235			
Fit of shaft in impeller	0.0027T	0.0042T			
Pulley hub					
Shaft diameter	0.7435	0.7445			
Bore inside diameter	0.7460	0.7465			
Fit of shaft in hub	0.0015T	0.0030T			
Idler gear					
Bearing bore inside diameter	1.9785	1.9795			
Bearing outside diameter	1.9800	1.9810			
Fit of bearing in gear	0.0005T	0.0025T			
Bearing inside diameter	1.0000	1.0008			
Shaft diameter	0.9990	1.0000			
Fit of shaft in bearing	0.0000	0.0018L			
Shaft bore in block inside diameter	0.9980	0.9990			
Fit of shaft in block	0.0000	0.0020T			
Adapter fuel injection pump					
Bearing bore inside diameter	1.0630	1.0640			
Bearing outside diameter	1.0650	1.0655			
Fit of bearing in adapter	0.0010	0.0025T			
Bearing inside diameter	0.8750	0.8770			
Shaft diameter	0.8735	0.8740			
Clearance of shaft in bearing	----------	----------	0.0010	0.0035	
TURBOCHARGER:					
Shaft end play					
Bearing to turbine	----------	----------	0.0040	0.0060	
Bearing to retainer plate	----------	----------	0.0010	0.0030	
Total end play	----------	----------	0.0050	0.0090	
Impeller to housing clearance	----------	----------	0.0150	0.0200	
Maximum shaft radial play (impeller end)	----------	----------	----------	0.0220	
TRANSMISSION:					
Torque converter housing					
Converter regulator spring					
Free length	----------	1.2060	----------	----------	1.2060
Length under load					
At 23.4 to 28.6 lbs.	----------	1.0000	----------	----------	1.0000
At 40.9 to 54.3 lbs.	----------	0.8500	----------	----------	0.8500
Converter lube spring					
Free length	----------	1.4400	----------	----------	1.4400
Length under 5.68 to 6.82 lbs.	----------	1.0000	----------	----------	1.0000
Inner thrust bearing race thickness	0.0300	0.0320	----------	----------	0.0280
Outer thrust bearing race thickness	0.1230	0.1260	----------	----------	0.1200
Freewheel unit					
Freewheel cam-surface wear	----------	----------	----------	*	0.0050
Clutch assembly roller diameter	0.3477	0.3480	----------	*	0.3472
First turbine driven gear roller cage diameter	3.4372	3.4377	----------	*	3.4272
Reverse clutch and planetary					
Reverse clutch reaction plate thickness	0.1070	0.1230	----------	----------	0.0970
Friction plate thickness	0.1500	0.1560	----------	----------	0.1300
Range carrier assembly gear end play	----------	0.0550			
Range clutch anchor face wear	----------	0.0200			
Reverse clutch piston return spring					

*Total wear of freewheel parts (2 x roller wear & 2 x cam surface wear & race wear) shall not exceed 0.0100 inch. All rollers must be free in cage but must not fall out.

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
TRANSMISSION—Continued.					
Free length		6.127			
Length under load					
47.1 to 49.9 lb.		4.8000			
57.0 to 63.0 lb.		4.4500			
Reverse clutch plate pack thickness	1.1850				
Forward clutch and planetary					
Forward clutch range carrier assembly gear end play.		0.0550			
Friction plate thickness	0.1500	0.1560			0.1300
Reaction plate thickness	0.1070	0.1230			0.0970
Range clutch anchor face wear		0.0200			
Forward clutch plate pack thickness	0.6910				
High range clutch					
Reaction plate surface face wear		0.0200			
Reaction plate thickness	0.1070	0.1230			0.0970
Friction plate thickness	0.1500	0.1560			0.1300
Piston return spring					
Free length	0.2500	0.3000			
Piston face wear		0.0200			
Clutch plate pack thickness	0.3670				
Charging oil pump					
Driven gear shaft diameter	0.7500	0.7500			0.7490
Control valve					
Main pressure regulator valve to valve body clearance.				0.0040	
Main regulator spring					
Free length		3.0550			
Length under load					
7.50 to 8.30 lb.		2.7000			
28.0 to 29.0 lb.		1.7700			
Trimmer spring					
Free length		2.9000			
Length under load					
25.60 to 31.20 lb.		2.3840			
72.00 to 88.00 lb.		1.4500			
Trimmer valve to valve body clearance				0.0035	
Clutch cutoff valve spring					
Free length		3.2000			
Length under load					
27.9 to 34.1 lb.		2.3800			
Clutch cutoff					
Valve to valve body clearance				0.0040	
Cutoff valve plug to valve retainer plug clearance				0.0040	
Selector valve to valve body clearance				0.0030	
Selector detent spring					
Free length		1.1400			
Length under load					
13.60 to 14.00 lb.		0.7800			
AXLES:					
Front axle					
Differential bearing cone inside diameter	3.2500	3.2510	0.0030T	0.0050T	
Differential bearing cup outside diameter	5.3750	5.3760	0.0010T	0.0040T	
Carriage cage cone inside diameter	2.1250	2.1255	0.0010T	0.0020T	
Carriage cage cup outside diameter	4.8750	4.8760	0.0010T	0.0030T	
Carriage cage cone inside diameter	2.2500	2.2505	0.0010T	0.0120T	
Hub cone inside diameter	4.6250	4.6260	0.0008T	0.0012L	
Hub cup outside diameter	7.1250	7.1260	0.0010T	0.0040T	

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
AXLES:—Continued.					
Front axle—Continued.					
Wheel bearing cone inside diameter	4.0000	4.0010	0.0002L	0.0022L	
Wheel bearing cup outside diameter	6.1875	6.1885	0.0010L	0.0040L	
Forward bearing pinion cage bearing bore	4.8730	4.8740	0.0010T	0.0030T	
Outside diameter	7.6920	7.6950	0.0020T	0.0060T	
Axle shaft bearing surface outside diameter	2.1450	2.1500			
Spline outside diameter	2.1170	2.1220			
Pinion shaft					
Large outside diameter	1.8755	1.8760	0.0005L	0.0015T	
Small outside diameter	1.3750	1.3755	0.0005L	0.0015T	
Differential spider gear surface outside diameter.	1.1220	1.1240	0.0000	0.0030T	
Bore inside diameter	2.1700	2.1720			
Planetary ring gear hub bearing bore inside diameter.	3.9100	3.9120	0.0010L	0.0050L	
Sleeve bearing bore inside diameter	3.8740	3.8760	0.0010T	0.0050T	
Backlash	0.0110	0.0170			
Planetary pinion					
Bore inside diameter	1.8800	1.8790	0.0070L	0.0090L	
Length	2.3470	3.3510	0.0320	0.0410	
Outside diameter of teeth	3.5650	3.5700			
Backlash	0.0060	0.0120			
Planetary sun gear					
Inside diameter	1.9410	0.9460			
Length	2.4710	2.4800	0.0000 Nom.	0.0770 Nom.	
Outside diameter of teeth	4.3200	4.3250			
Backlash	0.0060	0.0100			
Carrier pinion roller bearing					
Inside diameter	1.3775	1.3780	0.0003T	0.0013T	
Outside diameter	3.1491	3.1496	0.0005L	0.0019L	
Axle pin bearing					
Rear axle					
Differential cone inside diameter	2.8125	2.8130	0.0030T	0.0050T	
Differential bearing cup outside diameter	4.7244	4.7254	0.0010T	0.0040L	
Carirer cage cone inside diameter	1.8750	1.8755	0.0010T	0.0020T	
Carrier cage cup outside diameter	4.4375	4.4385	0.0010T	0.0030T	
Carrier cage cone inside diameter	1.7500	1.7505	0.0010T	0.0020T	
Hub cone inside diameter	3.3750	3.3760	0.0002L	0.0022L	
Hub cup outside diameter	5.3750	5.3760	0.0010T	0.0040L	
Wheel bearing cone inside diameter	4.2500	4.2510	0.0002L	0.0022L	
Wheel bearing cup inside diameter	6.3750	6.3760	0.0010T	0.0040T	
Forward bearing pinion cage bearing bore	4.4355	4.4365	0.0010T	0.0030T	
Outside diameter	7.0040	7.0070	0.0020T	0.0060L	
Axle shaft bearing surface outside diameter					
Spline outside diameter					
Pinion shaft					
Large outside diameter	1.6210	1.6220	0.0070L	0.0090L	
Small outside diameter	1.1250	1.1255	0.0005L	0.0015T	
Differential spider gear surface outside diameter.	0.9960	0.9980	0.0000	0.0030T	
Bore inside diameter	1.9200	1.9600			
Planetary ring gear hub bearing bore inside diameter.	3.3760	3.3780	0.0012L	0.0042L	
Sleeve bearing bore inside diameter	3.4090	3.4110	0.0010T	0.0050T	
Backlash	0.0110	0.0170			
Planetary pinion					
Inside diameter	1.6290	1.6300	0.0070L	0.0090L	

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
AXLES:—Continued.					
Rear axle—Continued.					
Length	2.0980	2.1020	0.0300	0.0530	
Outside diameter of teeth	2.9600	2.9650½			
Backlash	0.0090	0.0120			
Planetary sun gear					
Outside diameter of teeth	3.5900	3.5950			
Backlash	0.0060	0.0100			
Carrier pinion roller bearing					
Inside diameter	1.3775	1.3780	0.0003T	0.0013T	
Outside diameter	2.8341	2.8346	0.0000	0.0015L	
Axle pin bearing					
WHEEL BRAKES:					
Wheel cylinder					
Housing inside diameter	1.7500	1.7530			
Piston outside diameter	1.7455	1.7465			
Spring					
Free length	3.1100	3.1400			
Solid height	----------	0.6250			
Length under load					
At 1.5 to 2.5 lbs.	2.0000				
Shoe return spring					
Front brakes					
Free length	----------	6.8750			
Extended length	----------	8.5625			
Length under load					
At 67 to 83 lbs.	----------	7.3125			
Rear brakes					
Free length	----------	7.5625			
Extended length	----------	9.5000			
Length under load at 75 to 85 lbs.	----------	8.7500			
Adjusting cam spring					
Front brake					
Free length	1.0620				
Length under load at 375 to 450 lbs.	0.8750				
Rear brake					
Free length	1.3437				
Length under load at 325 to 340 lbs.	1.1875				
Anchor pin					
Front brake outside diameter	1.3685	1.3705	0.0010T	0.0040T	
Rear brake outside diameter	1.1180	1.1200	0.0040L	0.0075L	
Anchor pin bearing					
Front brake outside diameter	1.3730	1.3740			
Bearing bore in shoe	1.4365	1.4380			
AIR COMPRESSOR:					
Cylinder bore					
Out of round	----------	0.0020			
Piston clearance	0.0020	0.0040	0.0010	0.0040	
Tapered	----------	0.0030			
Piston outside diameter	2.4960	2.4960			
Piston rings					
Side clearance			0.0015	0.0030	
Gap width	0.0070	0.0190			
Piston pin					
Clearance in connecting rod bearing	----------	----------	----------	0.0015	
Clearance in piston bore	----------	----------	0.0010	0.0060	
Top of cylinder block to inlet valve seat	0.1010	0.1130	----------	----------	0.1450

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
AIR COMPRESSOR:—Continued.					
Crankshaft					
Journal out of round	----------	0.0010			
Connecting rod clearance	----------	----------	0.0003	0.0021	
Valve travel, discharge valve	0.0360	0.0580			
Governor					
Valve travel	0.0300	0.0400			
TANDEM HYDRAULIC PUMP:					
Cover, port end					
Bearing bores	1.9365	1.9375			
Bearing carrier					
Bearing bores	1.9365	1.9375			
Cover, end					
Bearing bores	1.9365	1.9375			
Wear plate					
Bearing bores	1.9370	1.9380			
Thickness	0.3737	0.3742	----------	----------	0.0020*
Gear depth	0.1870	0.1970			
Gear hub outside diameter	1.2895	1.2900			
Roller bearings					
Inside diameter	1.2895	1.2900	0.0010	0.0024	0.0010*
Outside diameter	1.9370	1.9375			
STEERING HYDRAULIC PUMP:					
Cover					
Bearing bores	1.0290	1.0330			
Adapter					
Bearing bore	1.0290	1.0330			
Pilot diameter	3.2480	3.2500			
Bore diameter	2.0458	2.0463			
Drive bore diameter	1.3740	1.3750			
Bearing inside diameter	0.8764	0.8769			
Shaft diameter	0.8744	0.8749			
Gear diameter					
Drive gear	2.0733	2.0745			
Driven gear	2.0733	2.0745			
Wear plate					
Outside diameter	4.0940	4.1350			
Thickness	0.1708	0.1718			
STEERING GEAR:					
Spring, centering					
Free length					
Length under load at					
Bearing, steering arm					
Outside diameter	1.5000	1.5005			
Inside diameter	1.3790	1.3795			
Bearing, steering rack shaft					
Outside diameter	1.2535	1.2520			
Inside diameter	1.1255	1.1260			
Housing					
Steering shaft bearing bore	1.2480	1.2500			
Steering gear rack shaft					
Bearing surface outside diameter	1.3750	1.3750			
Stub shaft bearing surface outside diameter	1.2300	1.2400			
Plunger, valve centering, outside diameter	0.3931	0.3935			
Needle bearing, Adapter					
Outside diameter					

*Thrust plate surface must be smooth. Any severe scoring or marking of face would be detrimental to pump efficiency.

*Bearing wear not readily determined without possible damage.

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
STEERING GEAR—Continued.					
Inside diameter					
HYDRAULIC CONTROL VALVE:					
Spring, return relief					
Free length	1.1300	1.1900			
Spring, relief valve					
Free length	1.6870	1.7490			
Spring, plunger return					
Free length	1.5940	1.6560			
Spring, detent, boom spool					
Free length	0.6570	0.7190			
Solid height	0.2590				
Length under load at 21 to 23 lb.	0.3020	0.3120			
Spring, check					
Free length	1.9690	2.0310			
Spring, spool return					
Free length	3.9065	3.9685			
Solid height	1.1710				
Plunger, relief valve					
Guide bore inside diameter	0.4900	0.5100			
Outside diameter					
Large end	0.6780	0.6980			
Small end	0.6150	0.6350			
Length	0.8650	0.8850			
Sleeve, spool					
Inside diameter	1.3655	1.3855			
Outside diameter					
Large end	1.5950	1.6000			
Small end	1.4950	1.5000			
Length	1.9900	2.0100			
Sleeve, check plunger short					
Inside diameter	0.8720	0.8820			
Outside diameter					
Shank	1.0004	1.0013			
Flange	1.0700	1.0800			
Length	0.6150	0.6350			
Sleeve, check plunger, long					
Inside diameter	0.8720	0.8820			
Outside diameter					
Shank	0.9997	1.0113			
Flange	1.0700	1.0800			
Length	1.4990	1.5000			
Seat, check valve					
Inside diameter	0.4990	0.5100			
Outside diameter	0.7710	0.7910			
Length	2.4580	2.4780			
Seat, main relief valve					
Outside diameter	1.0520	1.0720			
Inside diameter	0.4270	0.4470			
Length	0.9990	1.0100			
Holder, main relief valve seat					
Inside diameter	0.9990	1.0100			
Seat bore	1.0500	1.0700			
Outside diameter					
Shoulder	1.3650	1.3850			
Shank	1.3020	1.3220			
Flange	1.4270	1.4470			
Length	3.8020	3.8220			

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
HYDRAULIC CONTROL VALVE—Continued.					
Spacer, seat holder					
Inside diameter	1.2400	1.2600			
Outside diameter	1.4270	1.4470			
Length	1.7400	1.7600			
Plunger, relief valve					
Inside diameter	0.9990	1.0100			
Outside diameter					
Large end	1.3650	1.3850			
Small end	0.5210	0.5410			
Seat, relief pilot					
Inside diameter	0.2710	0.2910			
Outside diameter					
Shank	0.4990	0.5100			
Shoulder	0.6150	0.6350			
Length					
To shoulder	0.6150	0.6350			
Overall	0.7080	0.7280			
Plunger, relief valve					
Inside diameter	0.1460	0.1660			
Outside diameter					
Shank	0.2750	0.2780			
Shoulder	0.3340	0.3540			
Stub	0.1610	0.1710			
Length (overall)	1.2400	1.2600			
Plunger, check valve					
Inside diameter	0.5520	0.5720			
Outside diameter					
Shank	0.7340	0.7540			
Shoulder	0.9990	1.0100			
Length	1.3650	1.3850			
DEMAND VALVE:					
Seat, relief valve					
Inside diameter	0.4800	0.4840			
Outside diameter	0.7196	0.7198			
BRAKE AIR APPLICATION VALVE:					
Spring, primary piston return					
Free length	3.3906				
Solid height		0.3750			
Length under load at 15 to 18 lb.	0.5000	0.7500			
Spring, secondary inlet					
Free length	0.7812				
Solid height		0.2812			
Length under load at 7 to 10 lb.	0.3906	0.5312			
Spring, secondary piston return					
Free length	0.8281				
Solid height		0.2968			
Length under load at ½ to 1⅝ lb.	0.3906	0.6875			
Spring, primary inlet					
Free length	1.0937	1.1875			
Solid height		0.3281			
Length under load at 15 to 20 lb.	0.4218	0.5781			
Push rod					
Outside diameter	0.2400	0.2600			
Pin, outside diameter	0.9350	0.9450			
Inlet valve					
Outside diameter	0.7450	0.7470			
Inside diameter	0.5525	0.5725			

BRAKE AIR APPLICATION VALVE:—Continued.					
Guide, primary valve					
Inside diameter	0.7490	0.7510			
Outside diameter					
Shank	0.8650	0.8850			
Shoulder	1.3080	1.3100			
Piston, secondary metering					
Shaft outside diameter	0.3660	0.3700			
Piston outside diameter	2.6140	2.6180			
Body, lower valve					
Piston bore	2.6220	2.6260			
Valve bore	1.0620	1.0660			
Body, upper valve					
Piston bore	2.3740	2.3760			
Valve bore	1.3120	1.3140			
Piston, primary metering					
Shaft outside diameter	1.4330	1.4370			
Piston outside diameter	2.3670	2.3710			
POWER CLUSTER:					
Air cylinder					
Piston and rod					
Length	5.7120	5.7320			
Piston outside diameter	4.9846	5.0020			
Rod large outside diameter	0.6150	0.6350			
Rod small outside diameter	0.4275	0.4475			
Spring, piston return					
Free length	5.9600	5.9800			
Solid height	0.7700	0.7900			
Length under load at 23 to 39 lb.	1.0600	2.5600			
LIFT CYLINDER:					
Rod bearing					
Outside diameter	3.0030	3.0040			
Inside diameter	2.5080	2.5110			
Inside diameter after installation	2.5050	2.5110	0.0050	0.0150	2.5160
DUMP CYLINDER:					
Rod bearing					
Outside diameter	2.5030	2.5040			
Inside diameter	2.0090	2.0120	0.0020	0.0100	2.0160
CLAM CYLINDER:					
Rod bearing					
Outside diameter	2.0040	2.0050			
Inside diameter	1.5120	1.5140	0.0020	0.0100	1.5210
BOOM CYLINDER PIVOT BEARING:					
Outside diameter	3.5120	3.5130			
Inside diameter	3.0009	3.0011			
Inside diameter after installation	3.0005	3.0010			
BOOM:					
Frame and cross link pivot points					
Bore diameter	2.9990	3.0010	0.0020	0.0100	3.0160
Bearing					
Outside diameter	3.0030	3.0040			
Inside diameter	2.5080	2.5110			
Inside diameter after installation	2.5050	2.5110	0.0050	0.0150	2.5160
Bucket and cylinder pivot points					
Bore diameter	2.4990	2.5010	0.0020	0.0100	2.5160
Bearing					
Outside diameter	2.5030	2.5040			

Component	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
BOOM:—Continued.					
Inside diameter	2.0090	2.0120			
Inside diameter after installation	2.0050	2.0110	0.0050	0.0150	2.0210
DUMP LINK:					
Bearing bore diameter	2.4990	2.5010	0.0020	0.0100	2.5160
Bearing					
Outside diameter	2.5030	2.5040			
Inside diameter					
Inside diameter after installation	2.0050	2.0110	0.0020	0.0100	2.0160
CONNECTING PINS:					
Boom upper pin					
Outside diameter	2.5010	2.5030			2.4960
Lift cylinder pivot pin					
Outside diameter	2.4960	2.5000			2.4910
Bucket pivot pin					
Outside diameter	2.0010	2.0030			1.9910
Cross link pins					
Outside diameter	2.0010	2.0030			1.9960
BUCKET LINKAGE:					
Clam cylinder, upper pin diameter	1.4940	1.5010			
Clam cylinder, lower pin diameter	1.4940	1.5010			

CHAPTER 2

GENERAL MAINTENANCE INSTRUCTIONS

Section I. SPECIAL TOOLS AND EQUIPMENT

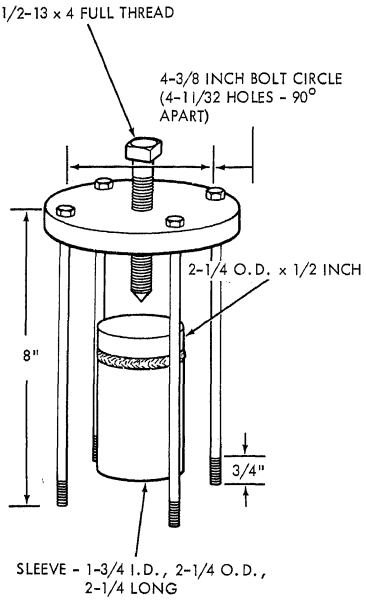
2–1. Special Tools and Equipment

The special tools and equipment supplied by the manufacturer to perform direct and general support and depot maintenance are listed in table 2–1. References indicating the use of these tools are listed in the table.

Table 2–1. Special Tools and Equipment

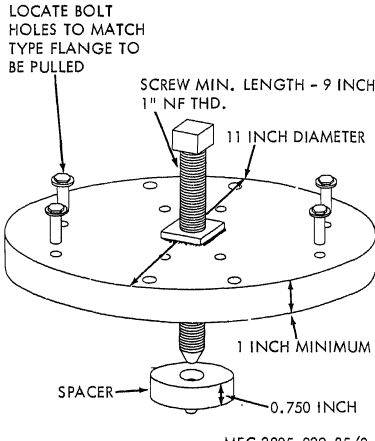
Item	FSN or Part No.	Reference		Use
		Figure	Paragraph	
Kit, hydraulic pressure test	AC100 (45225)		5–14	Testing pressure in hydraulic system.
Tool, tooth removal	AC314 (45225)			Removing teeth from bucket.
Installer, water pump seal	J22051 (33287)		3–15	Pressing water pump seal in bore.
Installer, water pump flinger	J22160–1 (33287)		3–15	Positioning flinger on water pump shaft.
Kit, cylinder compression	J22648 (33287)		3–46	Checking cylinder compression.
Adapter, injector tip (Kit–J22648)	J21616–1 (33287)		3–46	Replacing injector tip in cylinder head when checking compression.
Adapter, compression gage (Kit–J22648)	J22472 (33287)		3–46	Installing gage on cylinder.
Gasket, adapter (Adapter–J22472)	J1319–8 (33287)		3–46	Sealing adapter.
Check valve assembly (Adapter–J22472)	J7149–1 (33287)		3–46	Preventing loss of compression.
Gage and hose assembly (Kit–J22648)	J6692 (33287)		3–46	Checking cylinder compression.
Case, carrying (Kit–J22648)	J7125 (33287)			Stowing compression gage kit.
Tester, hydraulic pressure	PT100B (08832)		5–14	Checking pressure in hydraulic system.
Guide, cylinder packing	TC4497 (92392)		5–8	Installing cylinder packing.
Guide, cylinder packing	TC4498 (92392)		5–8	Installing cylinder packing.
Stud, flexible	TC7825 (92392)			Locating transmission when installing.
Tester, nozzle	Y900 (45225)		3–8	Testing injector nozzles.
Stand, repair, engine	1730A (45225)		2–30	Mount and rotate engine while performing repair.
Sling, adjusting	1805 (45225)		2–30	Removing or installing engine or where tipping of part is required.

Item	FSN or Part No.	Reference		Use
		Figure	Paragraph	
Cone, nose	3046137 (92392)			Connecting front and rear se tions.
Puller, pilot bearing	954 (45225)			Removing pilot bearing.



MEC 3805-239-35/2-1

Figure 2-1.

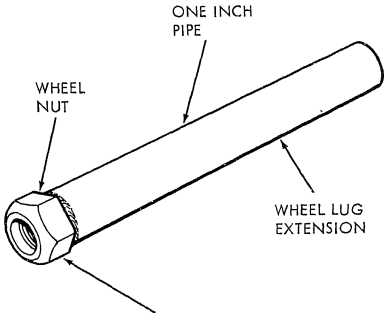


MEC 3805-239-35/2-

Figure 2-2.

2-2. Specially Designed Tools and Equipment

The specially designed tools and equipment lustrated on figures 2-1 through 2-3 and list in table 2-2 are for direct and general suppo and depot maintenance performing major o erhaul work on the loader. Tools and equi ment listed in table 2-2 are not available f issue, but must be fabricated by qualified dire and general support and depot maintenan personnel.



MEC 3805-239-35/2-3

Figure 2–3.

Table 2–2. Specially Designed Tools and Equipment

Item	Reference		Use
	Figure	Paragraph	
Puller, converter pump assembly	2–1	4–4	Removing torque converter pump.
Puller, drive flange	2–2	4–4	Removing transmission drive flanges.
Extension, wheel lug	2–3	7–4	Checking wheel bearing preload.

Section II. TROUBLESHOOTING

2–3. General

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the loader or any of its components. Each symptom stated is followed by a list of probable causes. The possible remedy recommended is described opposite the probable cause.

2–4. Engine Will Not Crank

Probable cause	*Possible remedy*
Defective starter	Replace starter (TM 5–3805–239–12).
Defective starter drive gear or flywheel ring gear	Repair starter (para 9–2) and/or ring gear (para 3–30).

2–5. Engine Cranks But Will Not Start

Probable cause	*Possible remedy*
Low starting rpm	Check starter and electrical system.
Engine timing not adjusted	Adjust timing (para 3–7).
Turbocharger not supplying sufficient air	Check turbocharger and repair (para 3–2).
Fuel system not operating properly	Check fuel system and repair.
Injector nozzles defective	Repair or replace injector nozzles (para 3–8).
Injection pump defective	Repair or replace injection pump (para 3–7).
Low compression	Check for defective valves and repair or replace valves (para 3–32).
Defective piston rings	Repair or replace piston rings (para 3–40).

2–6. Engine Misses or Operates Erratically

Probable cause	*Possible remedy*
Improper adjustment and timing	Adjust and time engine (para 3–7).
Engine operating at below normal temperature	Check thermostat operation (TM 5–3805–239–12) and replace thermostat.
Insufficient air to engine	Repair or replace turbocharger (para 3–2).
Fuel system not operating properly	Check fuel system and repair.
Defective fuel injector nozzles	Repair or replace fuel injector nozzles (para 3–8).
Defective fuel injection pump	Repair or replace fuel injection pump (para 3–7).
Low compression	Check for defective valves and repair or replace valves (para 3–23).
Worn or broken piston rings	Replace piston rings (para 3–40).

2–7. Engine Overspeeds

Probable cause	*Possible remedy*
Governor not adjusted properly	Adjust injection pump governor (para 3–7).
Fuel system not operating properly	Check and repair fuel system.
Oil in air system	Check air system and tubocharger and repair (para 3–2).
Defective fuel injector nozzles	Repair or replace fuel injector nozzles (para 3–8).
Injector pump not properly timed	Time injector pump (para 3–7).

2–8. Engine Low On Power

Probable cause	*Possible remedy*
One or more cylinders not firing	Check injector nozzles and repair or replace (para 3–8).
Fuel injection pump not properly timed	Time injection pump (para 3–7).
Defective fuel injection pump	Repair or replace fuel injection pump (para 3–7).
Defective fuel system	Repair fuel system.
Defective turbocharger	Repair or replace turbocharger (para 3–2).
Leaking exhaust system reducing pressure to turbocharger	Check and repair exhaust system (para 3–10).
Engine overheated	Check lubrication system (para 3–17 thru 3–19) and cooling systems (para 3–13 thru 3–15).
Low compression	Check engine and repair as necessary.
Worn or broken piston rings	Replace piston rings (para 3–40).

2–9. Engine Will Not Idle Properly

Probable cause	*Possible remedy*
Engine not properly timed	Time engine (para 3–7).
Defective fuel injector nozzles	Repair or replace injector nozzles (para 3–8).
Injection pump not adjusted properly	Adjust injection pump (para 3–8).
Governor not adjusted properly	Adjust governor (para 3–8).

2–10. Engine Exhaust Smokes Excessively

Probable cause	*Possible remedy*
Engine running too cool for proper combustion	Check cooling system. Replace thermostat (para 3–13).
Defective fuel injector nozzles or gaskets	Repair injector nozzles and replace gaskets (para 3–8).
Contaminated fuel or water in fuel	Service fuel filters (TM 5–3805–239–12).
Low compression	Check compression and repair engine as necessary to correct.
One or more cylinders not firing	Check fuel and air systems and repair engine as necessary to correct.
Worn or stuck piston rings or worn cylinder sleeves	Repair or replace pistons and/or sleeves (para 3–40 and 3–43).
Worn valves or valve guides	Repair or replace valves or valve guides (para 3–23).

2–11. Engine Knocks or is Noisy

Probable cause	*Possible remedy*
Excessive valve clearnace	Adjust valve clearance (para 3–22).
Defective or worn valve rocker arm assembly	Replace rocker arm assembly (para 3–21).
Bent valve push rod	Replace push rod (para 3–23).

Probable cause	*Possible remedy*
Defective starter, generator, or water pump	Replace defective components (TM 5-3805-239-12).
Defective turbocharger	Replace turbocharger (TM 5-3805-239-12).
Worn main bearings	Replace bearings as necessary (para 3-38).
Worn connecting rod bearings	Replace bearings as necessary (para 3-41).
Broken piston ring	Replace piston ring (para 3-40).
Worn cylinder sleeve or piston	Replace worn sleeves (para 3-43) or pistons (para 3-40).
Loose piston pin or pins	Replace piston pins (para 3-40).

2-12. Low or No Oil Pressure

Note. Make oil pressure checks with engine at operating temperature. Coolant temperature gage should read 160° to 200° F.

Probable cause	*Possible remedy*
Leakage in oil system	Check system for leaks and correct.
Pressure gage or sending unit inoperative	Replace gage or sending unit (TM 5-3805-239-12).
Clogged oil pump screened	Clean oil pump screen (para 3-18).
Defective oil pump	Repair or replace oil pump (para 3-18).

2-13. Excessive Oil Consumption

Probable cause	*Possible remedy*
Leakage in oil system	Check system for leaks and correct.
Defective gaskets or oil seals	Replace defective oil seals in engine (para 3-31) and turbocharger (para 3-2).
Defective or leaking oil cooler	Replace oil cooler (TM 5-3805-239-12).
Defective piston rings	Replace rings (para 3-40).
Worn pistons or cylinder sleeves	Replace pistons (para 3-40). or cylnider sleeves (para 3-43).
Worn valve guides	Replace valve guides (para 3-23).

2-14. Abnormal Engine Coolant Temperatures

Probable cause	*Possible remedy*
Defective temperature gage or radiator	Replace gage or radiator (TM 5-3805-239-12).
Poor coolant circulation	Check cooling system and correct.
Defective thermostat	Replace thermostat (TM 5-3805-239-12).
Defective water pump	Replace water pump (TM 5-3805-239-12) or repair water pump.

2-15. Starter Will Not Crank Engine

Probable cause	*Possible remedy*
Batteries weak	Charge or replace batteries (TM 5-3805-239-12)
Defective neutral start switch or loose wiring	Replace switch and check wiring (TM 5-3805-239-12)
Defective starter	Repair or replace starter (para 9-2).

2-16. Turbocharger Does Not Supply Enough Air

Probable cause	*Possible remedy*
Dirty air cleaner	Service air cleaner (TM 5-3805-239-12).
Restricted intake manifold or piping	Remove restriction (TM 5-3805-239-12).
Defective turbocharger or components	Repair or replace turbocharger (para 3-2).

2-17. Turbocharger Vibrates and is Noisy

Probable cause	*Possible remedy*
Loose or broken mounting parts	Replace parts (TM 5-3805-239-12).
Insufficient oil to turbocharger	Check turbocharger oil lines and replace lines if necessary (TM 5-3805-239-12).
Defective bearings or rotating components	Repair or replace turbocharger (para 3-2).

2-18. Fuel Injection Pump not Delivering Fuel

Probable cause	*Possible remedy*
Clogged filters or fuel lines	Service fuel system (TM 5-3805-239-12).
Improper grade of fuel	Drain fuel and replace with proper grade.
Defective transfer pump	Repair or replace transfer pump (para 3-7).
Defective fuel injection pump	Repair or replace fuel injection pump (para 3-7).

2-19. Fuel Injectors not Operating Properly

Probable cause	*Possible remedy*
Defective fuel injection pump	Repair or replace fuel injection pump (para 3-7).
Injector pump not properly timed	Time injector pump (para 3-7).
Defective injector nozzles	Repair or replace injector nozzles (para 3-8).

2-20. Generator not Charging

Probable cause	*Possible remedy*
Drive belts slipping or broken	Adjust or replace drive belts (TM 5-3805-239-12).
Defective voltage regulator	Replace regulator (TM 5-3805-239-12).
Defective generator	Repair generator (para 9-4). or replace generator (TM 5-3805-239-12).

2–21. Loader Will Not Go In Motion

Probable cause	*Possible remedy*
Parking brake will not release	Repair or replace parking brake (para 8–16).
Defective clutch cutoff valve	Repair or replace clutch cutoff valve (para 8–14).
Defective torque converter	Repair or replace torque converter (para 4–4).
Defective transmission	Repair or replace transmission (para 4–4).
Defective axle differential or planetary	Repair or replace axles (para 7–4 and 7–6).

2–22. Loader Moves but Does Not Operate Properly

Probable cause	*Possible remedy*
Defective clutch cutoff valve	Repair or replace clutch cutoff valve (para 8–14).
Defective torque converter	Repair or replace torque converter (para 4–4).
Defective transmission	Repair or replace transmission (para 4–4).
Defective axle differential or planetary	Repair or replace axles (para 7–4 and 7–6).

2–23. Loader Does Not Steer Properly

Probable cause	*Possible remedy*
Defective steering gear	Repair or replace steering gear (para 6–2).
Defective steering cylinder	Repair or replace steering cylinder (para 6–5).
Defective steering pump	Repair or replace steering pump (para 6–4).
Defective demand valve	Repair or replace demand valve (para 5–6).

2–24. Wheel Brakes do Not Operate Properly

Probable cause	*Possible remedy*
Brakes not properly adjusted	Adjust brakes (TM 5–3805–239–12).
Defective power cluster or master cylinder	Repair or replace power cluster (para 8–11).
Defective wheel cylinder	Repair or replace wheel cylinder (para 8–13).
Defective brake assembly	Repair or replace brake assembly (para 8–12).
Insufficient air pressure	Check air system and repair.
Defective air lines	Repair or replace air lines (TM 5–3805–239–12).
Defective or leaking air reservoir	Repair or replace air reservoir (TM 5–3805–239–12).
Defective compressor or governor	Repair or replace compressor (para 8–4).
Defective brake pedal valve	Repair or replace broken pedal valve (para 8–10).

2–25. Parking Brake Does Not Hold Loader

Probable cause	*Possible remedy*
Brake linkage bent or jammed	Repair or replace brake linkage (TM 5–3805–239–12).
Brake lining worn	Replace brake lining (para 8–16).
Defective drum or brake assembly	Repair or replace brake assembly (para 8–16).

2–26. Boom Does Not Operate Properly

Probable cause	*Possible remedy*
Defective hydraulic lines	Replace hydraulic lines (TM 5–3805–239–12).
Defective lift cylinders	Repair or replace lift cylinders (para 5–8).
Defective controls	Repair or replace controls (TM 5–3805–239–12).
Defective control valve	Repair or replace control valve (para 5–14).
Defective tandem hydraulic pump	Repair or replace hydraulic pump (para 5–4).
Defective hydraulic reservoir	Repair or replace hydraulic reservoir (TM 5–3805–239–12).

2–27. Bucket Does Not Dump Properly

Probable cause	*Possible remedy*
Defective hydraulic lines	Repair or replace hydraulic lines (TM 5–3805–239–12).
Defective dump cylinders	Repair or replace dump cylinders (para 5–8).
Defective controls	Repair or replace controls (TM 5–3805–239–12).
Defective control valve	Repair or replace control valve (para 5–14).
Defective tandem hydraulic pump	Repair or replace hydraulic pump (para 5–4).
Defective hydraulic reservoir	Repair or replace hydraulic reservoir (TM 5–3805–239–12).

2–28. Bucket Clam Does Not Operate Properly

Probable cause	*Possible remedy*
Defective hydraulic lines	Repair or replace hydraulic lines (TM 5–3805–239–12).
Defective clam safety valve	Repair or replace clam safety valve (para 5–10).
Defective clam cylinders	Repair or replace clam cylinders (para 5–8).
Defective controls	Repair or replace controls (TM 5–3805–239–12).
Defective control valve	Repair or replace control valve (para 5–14).
Defective tandem hydraulic pump	Repair or replace hydraulic pump (para 5–4).
Defective hydraulic reservoir	Repair or replace hydraulic reservoir (TM 5–3805–239–12).

2–29. General

a. Information in this section includes removal of the engine, transmission, front and rear axle, steering gear, and demand valve. Other major components were removed in TM 5–3805–239–12.

b. The drive unit of the loader consists of the four wheels and axles, driven by the engine through the transmission and drive shafts.

c. After removal of the engine the transmission can be removed from the frame. Any disassembly of the transmission must be done after removal from the loader.

d. Both axles can be removed from the unit without removal of the transmission. Disassembly of the axles must be done after removal from the loader.

2–30. Engine

a. Preparation. Refer to figure 2–4 for disconnect points.

(1) Operate loader (TM 5–3805–239–12) and run loader to place rear wheels up on four to six inch blocks.

(2) Refer to TM 5–3805–239–12 and drain cooling system and oil from the engine. Drain air from air reservoir. Drain oil from transmission.

(3) Refer to TM 5–3805–239–12 and remove the following components.

(*a*) Remove oil filters and hoses. Remove voltage regulator and hourmeter.

(*b*) Remove radiator and radiator support, hood, and air cleaner hood. Disconnect wires.

(*c*) Remove air cleaner and exhaust pipe.

(*d*) Disconnect cold weather starting tube from turbocharger elbow.

(*e*) Disconnect wires from rear of generator, oil pressure sending unit, starter ground wires, slave receptacle, and wires to circuit breaker above receptacle.

(*f*) Disconnect fuel lines from primer pump, line to fuel filter, line to injector pump, and return line from injectors. Remove primer pump and bracket.

(*g*) Disconnect and remove transmission oil lines from oil cooler and transmission. Remove transmission oil level gage and tube.

(*h*) Remove throttle linkage from fuel injection pump and oil cooler.

(*i*) Disconnect air outlet line from air compressor and remove line from governor and two lines to alcohol injector.

(*j*) Remove transmission oil filter.

(*k*) Remove auxiliary solenoid.

b. Removal. Refer to figure 2–4 and remove engine.

(1) Attach engine lifting sling to engine lifting eyes (fig. 2–4) and connect a suitable hoist to the lifting sling.

(2) Remove four screws, washers, and self-locking nuts securing engine mounting brackets (fig. 2–4).

(3) Remove two screws and remove access cover (fig. 2–4). Remove eight screws (fig. 2–4) connecting engine flywheel to transmission flexible disk. Remove screws with a wrench and socket extension. Turn engine crankshaft by hand to bring screws in line with hole in housing.

Note. Remove or install screws with care to prevent screws from dropping down into housing.

(4) Remove thirteen screws (fig. 2–4) securing transmission to flywheel housing.

(5) Lift engine with hoist and lifting sling, moving engine to the rear as it is lifted. Move engine at least two to three inches to clear torque converter pilot from bore in flywheel.

***Caution:* Move engine with care. Do not damage flexible disk when moving engine.**

(6) Move engine to the rear and lift up and away from loader.

Note. Lift engine carefully. Due to the spacing of the lifting eyes, the engine will turn and tilt slightly Avoid bumping frame as engine is moved.

(7) Install engine on engine repair stand.

c. Installation.

(1) Attach lifting sling and hoist to engine and lift from repair stand.

(2) Move engine to frame and lower into place on frame. Guide engine carefully while lowering.

(3) Move engine into place against transmission to aline flywheel with flexible disk and flywheel housing with transmission. Guide torque converter pilot into flywheel.

(4) Lower engine to frame and refer to

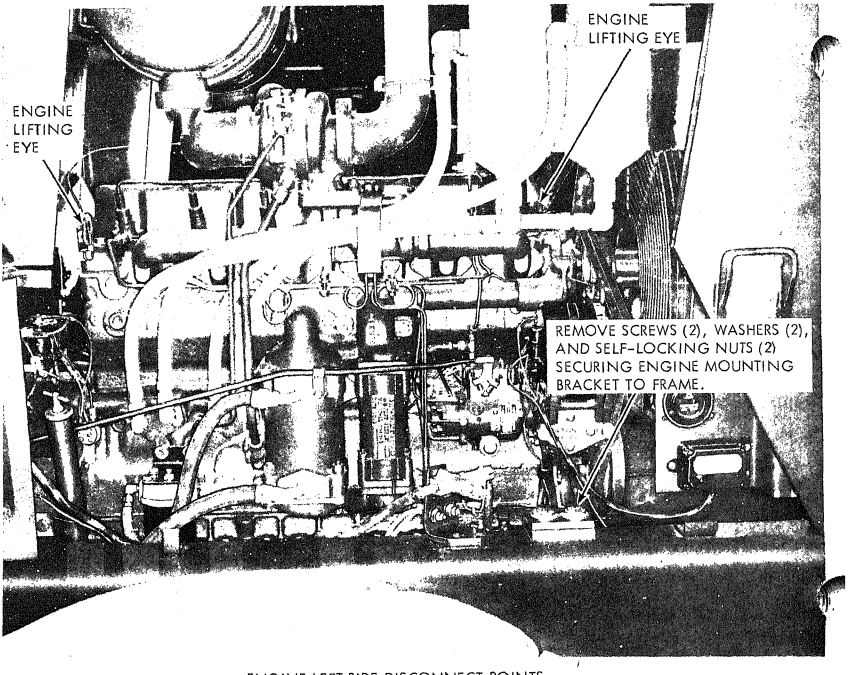


Figure 2–4. Engine, removal and installation.

figure 2–4 and *b* and *c* above and install the engine in the loader.

(5) Tighten screws (fig. 2–4) mounting transmission to engine flywheel housing to a torque of 30 to 35 foot-pounds.

(6) Tighten screws (fig. 2–4) securing flywheel to flexible disk to a torque of 41 to 49 foot-pounds.

(7) Tighten screws (fig. 2–4) securing engine mounting brackets to the frame to a torque of 120 to 130 foot-pounds.

2–31. Transmission

a. General. The transmission is mounted forward of the engine. The torque converter is directly driven by the engine flywheel. Supports for the transmission are attached to the frame on each side of the transmission.

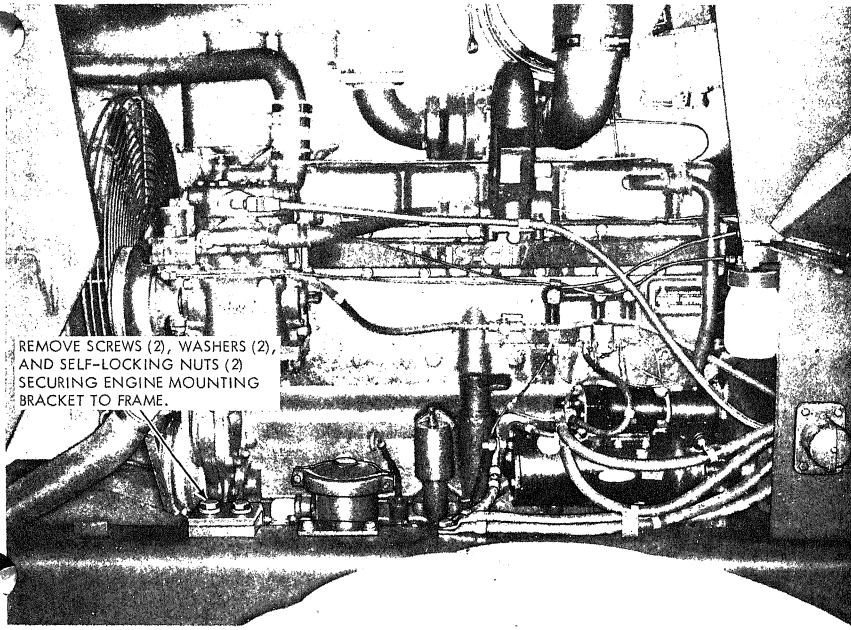
b. Removal.

(1) Refer to paragraph 2–30 and remove the engine from the loader.

(2) Refer to TM 5–3805–239–12 and drain the oil from the transmission.

(3) Refer to figure 2–5 and TM 5–3805–239–12 and remove or disconnect the following.

(*a*) Remove protective cover from master cylinders on left side of the engine.



ENGINE RIGHT SIDE DISCONNECT POINTS

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Figure 2–4—Continued.

(*b*) Remove air reservoir and air lines.

(*c*) Disconnect and remove drive shafts from transmission.

(*d*) Disconnect and remove parking brake linkage from transmission.

(*e*) Disconnect and remove transmission control linkage from transmission control valve.

(*f*) Disconnect and remove clutch cutoff valve tubing from transmission.

(*g*) Disconnect wires from transmission pressure sending units and temperature tubing from side of control valve.

(*h*) Disconnect two hoses (fig. 2–5) from the steering cylinders.

(*i*) Remove steering and tandem hydraulic pumps and lines.

(4) Connect a chain around the converter housing or to two upper mounting holes. Protect housing with cloth or soft material to prevent damage to converter. Attach hoist to chain.

(5) Install a jack under transmission and raise jack to support transmission.

(6) Refer to figure 2–5 and remove transmission mounting brackets from both sides of transmission.

(7) Lower jack and hoist to drop transmission below frame. Remove jack and guide

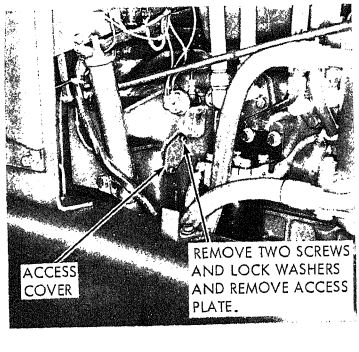


Figure 2–4—Continued.

transmission by tipping it to one side under frame.

(8) Lower transmission on to a suitable carrier and remove hoist. Move transmission to a suitable support.

c. Installation.

(1) Move transmission to loader and slide under frame. Connect chain and hoist to transmission.

(2) Lift transmission into position using hoist and a jack.

(3) Refer to figure 2–5 and install the transmission mounting brackets. Tighten screws securing brackets to transmission to a torque of 137 to 147 foot-pounds.

(4) Lower transmission to frame and install mounting bolts to hold brackets on frame. Tighten bolts to a torque of 120 to 130 foot-pounds.

(5) Refer to paragraph *b* above reverse the sequence of instructions to install the transmission connections.

(6) Refer to paragraph 2–30 and install the engine in the loader.

2–32. Axles

a. General. The two drive axles on the loader are rigid axles. Drive shafts from the transmission connect to differentials at the center of each axle. The differentials drive the shafts at-

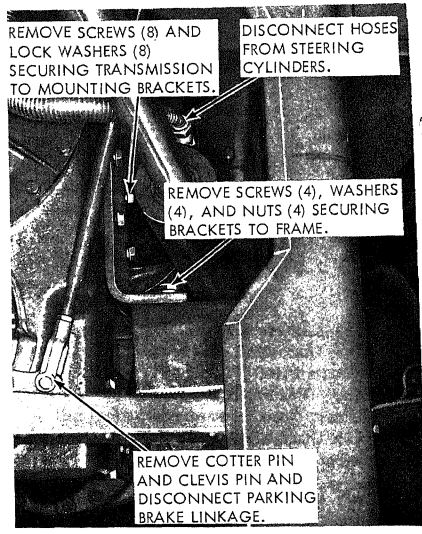


Figure 2–5. Transmission mounting brackets, removal and installation.

tached to planetary gears at each end of the axle. The planetaries drive the wheels.

b. Front Axle.

(1) *Removal.*

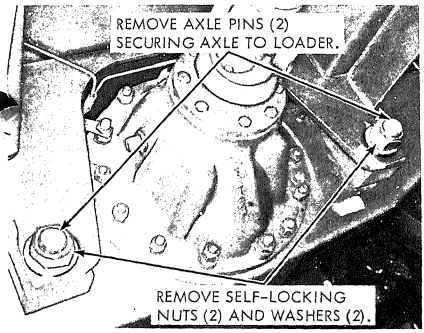
(*a*) Raise boom and bucket and install suitable supports under bucket and boom to prevent their falling. Leave boom lever in float position.

(*b*) Refer to TM 5–3805–239–12 and disconnect the drive shaft from the flange at the differential carrier.

(*c*) Refer to TM 5–3805–239–12 and disconnect hydraulic lines from wheel cylinders. Remove clamps and remove lines from axle.

(*d*) Install suitable jacks under the lower part of the front frame. Raise jacks to support frame.

(*e*) Refer to figure 2–6 and remove axle pins. Raise jacks slightly to take strain off pins.



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Figure 2–6. Front axle, removal and installation.

(*f*) Raise frame with jacks to clear axle and remove axle from loader.

(2) *Installation.*

(*a*) Raise frame with jacks to allow space to clear axle.

(*b*) Roll axle into place beneath frame. Lower frame to aline mounting holes with holes in axle.

(*c*) Install axle pins (fig. 2–6) through axle and frame and secure with self-locking nuts and washers. Tighten nuts to a torque of 900 to 950 foot-pounds. Remove jacks.

(*d*) Refer to TM 5–3805–239–12 and install hydraulic lines and connect drive shaft.

(*e*) Remove supports and lower boom and bucket to ground.

c. Rear Axle.

(1) Install suitable jacks under rear of frame or attach chain and hoist to towing pintle.

(2) Refer to TM 5–3805–239–12 and disconnect and remove the brake hydraulic lines from the wheel cylinders. Remove clamps and remove hydraulic lines from axle.

(3) Refer to TM 5–3805–239–12 and disconnect the lubrication hoses from the axle pivot pins.

(4) Refer to TM 5–3805–239–12 and disconnect the drive shaft from the differential.

(5) Refer to figure 2–7 and remove rear axle. Raise jacks or hoist frame with towing pintle to clear axle. Roll axle from loader.

(6) Refer to figure 2–8 and remove rear axle supports from loader.

d. Installation.

(1) Refer to figure 2–8 and install rear axle supports on loader. Install washers (0.010 inch thick) (13) as required to maintain 0.0050 to 0.0100 inch clearance between washer (12) and frame. Tighten nuts (11) to a torque of 1325 to 1375 foot-pounds.

(2) Refer to figure 2–7 and *a* above and reverse the procedures to install the rear axle on the loader.

(3) Tighten self-locking nuts (7) to a torque of 900 to 950 foot-pounds.

2–33. Steering Gear

a. General. The steering consists of a steering wheel which rotates a shaft. As the shaft rotates it opens a hydraulic valve, sending hydraulic oil to the steering cylinders. Movement of the cylinder rods turn the loader on the frame connecting pins.

b. Removal. Refer to figure 2–9 for steering gear disconnect points.

(1) Refer to TM 5–3805–239–12 and remove the following components.

(*a*) Remove the steering wheel from the shaft.

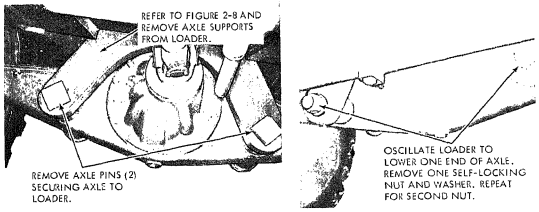


Figure 2–7. Rear axle, removal and installation.

(*b*) Remove the screws and nuts securing the cowl to the platform.

(*c*) Remove transmission control lever and linkage from steering column.

(*d*) Disconnect four hoses from the steering control valve. Cover or plug openings in valve and hoses to prevent entrance of dirt or foreign matter.

(*e*) Remove steering arm and tie rod from the steering gear.

(2) Remove the U-bolt (fig. 2–9) and nuts securing the steering column to the instrument panel.

(3) Remove steering gear covers from the floor of the platform assembly.

(4) Support the steering gear with a suitable hoist or other means and remove three screws (fig. 2–9) and lock washers securing steering gear to bottom of platform.

(5) Carefully remove the steering gear from the loader.

c. Installation.

(1) Refer to figure 2–9 and *b* above and reverse the instructions to install the steering gear.

(2) Remove plugs and install hoses on steering gear and tighten hose to a torque of 20 to 30 foot-pounds. Use flare nut wrenches as applicable to tighten flare nuts.

(3) Operate loader hydraulic system and check for leaks. Check oil level in hydraulic reservoir (TM 5–3805–239–12) and add oil if necessary.

2–34. Brake Pedals and Valve

a. General. The right brake pedal and valve is mounted on the platform assembly below the instrument panel. A rod connects the left pedal with the right pedal so that when the left pedal is depressed, braking action is the same as if the pedal attached to the valve was depressed.

b. Removal. Refer to figure 2–10 for disconnect points.

(1) Refer to TM 5–3805–239–12 and drain air pressure from air reservoir.

(2) Refer to TM 5–3805–239–12 and figure 2–10, disconnect air lines from brake valve. Plug openings in valve and lines to prevent entrance of dirt or foreign matter.

(3) Disconnect wires from stop light switch (fig. 2–10).

(4) Remove six screws, nuts, and lock washers and remove brake pedal and valve and left brake pedal from the loader.

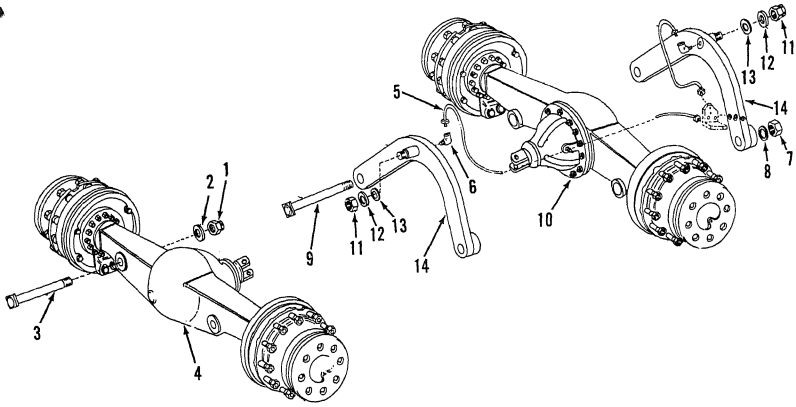
c. Installation. Refer to figure 2–10 and install the brake pedal and valve and the left brake pedal on the platform.

2–35. Demand Valve

a. General. The demand valve, mounted under the left side of the platform, diverts a portion of the hydraulic flow from the tandem hydraulic pump to the steering system when the steering hydraulic pump is not producing enough hydraulic pressure. As engine speed increases the demand on the tandem pump decreases and the steering pump supplies an adequate amount of oil to operate the steering system.

b. Removal.

Note. Whenever any part of the hydraulic system is removed or disconnected, plug or cap all openings to prevent the entrance of dirt or foreign material.



1 Nut, self-locking, 1-1/2-NF (2 rqr)
2 Washer, flat, 1-1/2 in. (2 rqr)
3. Axle pin (2 rqr)
4 Front axle
5 Lubrication hose (2 rqr)
6 Elbow (2 rqr)
7 Nut, self-locking, 1-1/2-NF (2 rqr)
8 Washer, flat, 1-1/2 in. (2 rqr)
9 Axle pin (2 rqr)
10 Rear axle
11 Nut, self-locking (2 rqr)
12 Washer, flat (2 rqr)
13 Washer, flat, 0. 010 in. thk (as rqr)
14 Axle support (2 rqr)

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Figure 2–8. Axles and supports, exploded view.

(1) Remove protective cover over power clusters on left side of loader.

(2) Refer to figure 2–11 and remove the demand valve.

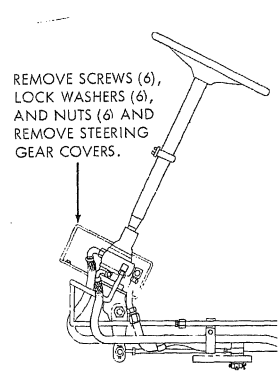
(3) Plug or cap all openings in the valve and hydraulic lines.

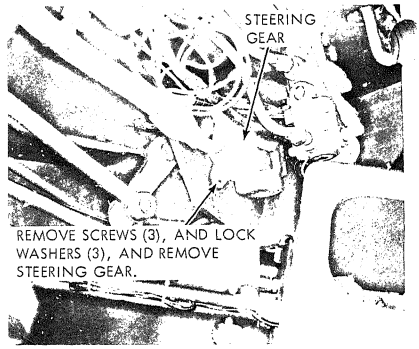
c. Installation.

(1) Refer to figure 2–11 and install the demand valve on the loader.

(2) Operate loader hydraulic system and check for leaks. Correct leaks if necessary.

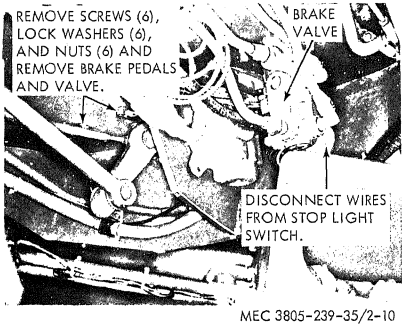
(3) Check oil level in hydraulic reservoir (TM 5–3805–239–12) and add oil if necessary.





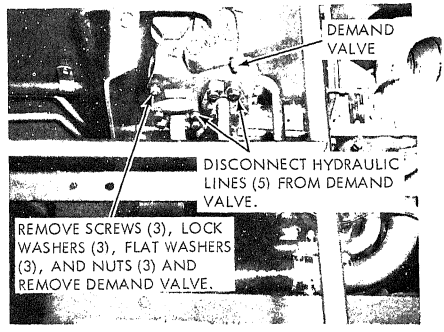
MEC 3805-239-35/2-9

Figure 2-9. Steering gear, removal and installation.



MEC 3805-239-35/2-10

Figure 2-10. Brake pedal and valve, removal and installation.



MEC 3805-239-35/2-11

Figure 2-11. Demand valve, removal and installation.

CHAPTER 3

ENGINE REPAIR INSTRUCTIONS

Section I. AIR SYSTEM

3–1. General

a. The air system consists of the air cleaner, intake manifold, and the turbocharger. Air is drawn in through the air cleaner where dust and foreign matter are removed. From the air cleaner the air passes through the compression side of the turbocharger.

b. The turbocharger is driven by the engine exhaust, with the impeller in the air compression side rotating and increasing the air supply to the engine. The air leaving the turbocharger enters the intake manifold and is distributed to the cylinders.

3–2. Turbocharger

a. General. The turbocharger is mounted on the exhaust manifold, with the exhaust gases flowing through the turbine side of the turbocharger and driving the impeller. The exhaust gases pass out the side of the turbocharger through an elbow and exhaust pipe and are discharged to the atmosphere. The air is delivered through a curved elbow to the intake manifold. A tube, connected to the elbow supplies filtered air to the air compressor.

b. Removal.

(1) Refer to TM 5–3805–239–12 and remove the exhaust pipe, elbow, and disconnect air cleaner outlet from turbocharger.

(2) Refer to TM 5–3805–239–12 and remove the turbocharger from the engine.

Note. Loosen hose clamps connecting compressor air tube to outlet elbow and move hose along tube to clear outlet elbow.

c. Disassembly. Disassemble the turbocharger in the numerical sequence as illustrated on figure 3–1 and the following instructions.

(1) Install a ½ x ⅜ NPT pipe bushing (not supplied) into oil drain hole in bearing housing and screw a ½ NPT threaded piece of bar stock into bushing.

(2) Support bushing in a vise and remove clamp nut (1) and clamp (2) and remove turbine housing (3) and gasket (4) from turbocharger.

(3) Remove six screws (5) and compressor housing (6) and gasket (7).

(4) Refer to figure 3–2 and check and record shaft radial and end play as shown.

(5) Hold turbine blades with a soft cloth and remove nut (8) and washer (9). Nut has left hand thread. Press turbine wheel (10) from impeller (14). Remove impeller and shims (17).

(6) Lift the bearing housing (23, fig. 3–1) from turbine wheel (10). Remove the spring ring (13) and turbine shield (12) from shaft. Remove shaft sleeve (19) from bearing housing.

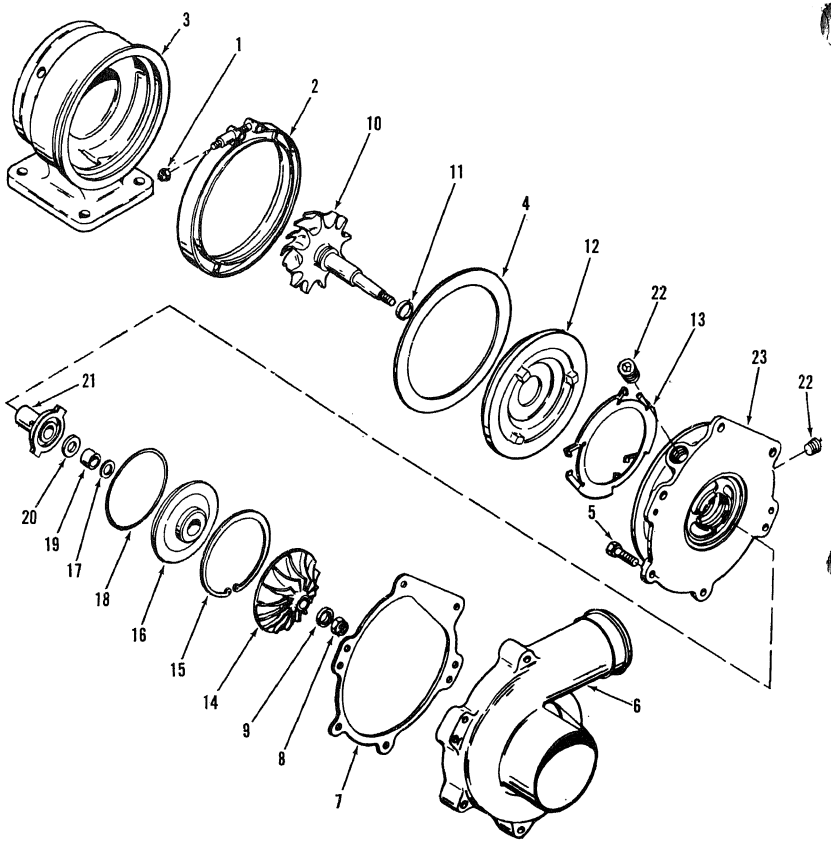
(7) Remove oil seal (11) from shaft. Do not damage seal. Remove retaining ring (15). Using a suitable driver, press oil seal (16), mating ring (20) and bearing (21) from housing. Remove packing (18) and pipe plugs (22) from bearing housing.

d. Cleaning. Clean all metal parts in diesel fuel (DF) or kerosene and remove carbon deposits with a nylon brush.

Caution: **Never use a caustic solution to clean turbocharger parts. Never use a wire brush which could score highly polished parts.**

e. Inspection and Repair.

(1) Inspect turbine and compressor housings for erosion, pit marks, cracks, and damage. Inspect tapped holes for damaged threads. Repair damaged threads, if possible. Replace eroded, pitted, cracked, or damaged housings.



1 Clamp nut
2 Clamp
3 Turbine housing
4 Housing gasket
5 Screw, cap, hex-head (6 rqr)
6 Compressor housing
7 Housing gasket
8 Impeller nut
9 Washer
10 Turbine wheel
11 Oil seal
12 Turbine shield
13 Spring ring
14 Impeller
15 Retaining ring
16 Oil seal
17 Shim
18 Preformed packing
19 Shaft Sleeve
20 Mating ring
21 Bearing
22 Pipe plug (2 rqr)
23 Bearing housing

MEC 3805-239-35/3-1

Figure 3-1.

(2) Inspect turbine wheel and shaft for nicked, bent, cracked, or missing blades. Check blades for evidence of rubbing on housing contour. Inspect seal groove for wear. Check bearing journals for wear, scoring, or overheating. Inspect bearing thrust surface for scoring, rough, surface and wear. Remove minor scoring with crocus cloth. Replace wheel if damaged, worn, or scored beyond repair.

(3) Inspect impeller for nicked, bent, cracked or missing blades. Check blades for evidence of rubbing on housing contour. Replace impeller if damage is beyond repair.

(4) Inspect machined surfaces of bearing housing for nicks and other damage. Inspect packing and seal seats for damage and wear. Replace damaged or worn housings.

(5) Inspect bearing bore and thrust surfaces for wear and roughness. Inspect flange for nicks. Replace worn or damaged bearing.

(6) Inspect oil seal for wear or scoring on carbon face. Check insert for free movement. Replace shaft seal and mating ring if worn or damaged.

(7) Inspect shield for flatness, scoring, erosion, or pitting. Replace shield if damaged. Replace spring ring if warped, damaged, or has lost spring tension.

(8) Replace clamp if cracked, distorted, has stripped threads, or has any other damage.

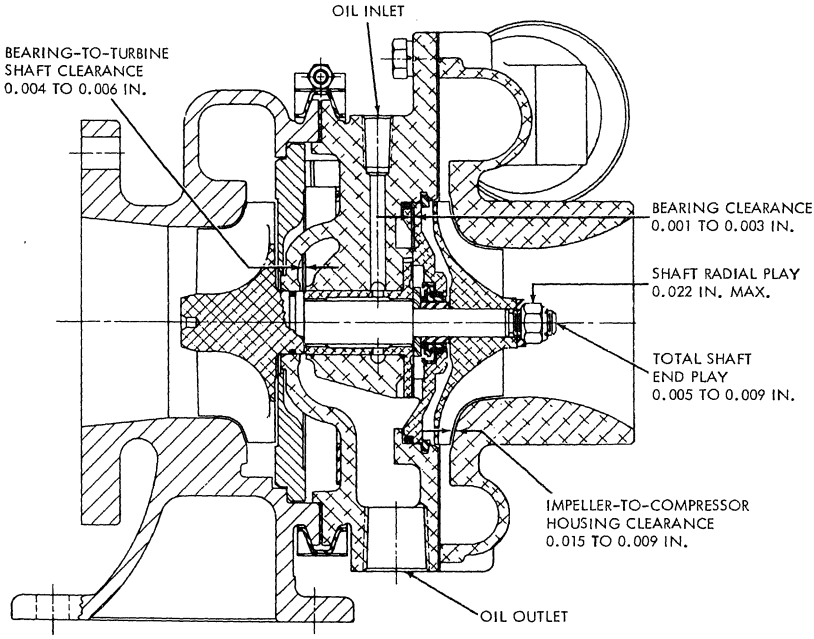


Figure 3-2. Turbocharger clearance check points.

(9) Check all clearances against tolerances listed in table 1–1. Replace all parts not conforming to repair and replacement standards.

(10) Replace all damaged or defective parts.

f. Reassembly. Reassemble the turbocharger in reverse of the numerical sequence as illustrated on figure 3–1 and the following instructions. Figure 3–2 illustrates the clearance check points to be observed during reassembly of the turbocharger.

(1) Install mounting fixture in oil drain hole in bearing housing and support fixture in vise with bearing housing in a horizontal position.

(2) Install two pipe plugs (22) and tighten plugs to a torque of 140 to 200 inch-pounds.

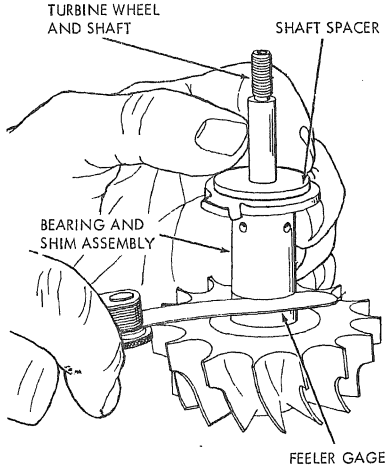
(3) Install bearing (21), mating ring (20), and sleeve (19) on shaft of turbine wheel (10) as illustrated in figure 3–3.

Note. Replacement bearings are supplied with a shim in place on the face of the bearings.

(4) Hold mating ring tight against shaft shoulder and measure clearance between bearing and shaft with a feeler gage. Clearance should be 0.0040 to 0.0060 inch. If clearance exceeds 0.0060, install new bearing.

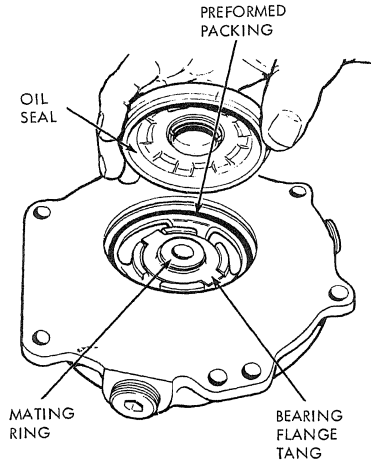
(5) Record clearance to determine total end play. Remove spacer and bearing from shaft.

(6) Install bearing into bearing housing with bearing flange tangs engaging spaces between bearing housing lugs (fig. 3–4).



MEC 3805-239-35/3-3

Figure 3–3. Measuring bearing to turbine shaft end play clearance.



MEC 3805-239-35/3-4

Figure 3–4. Assembling bearing housing.

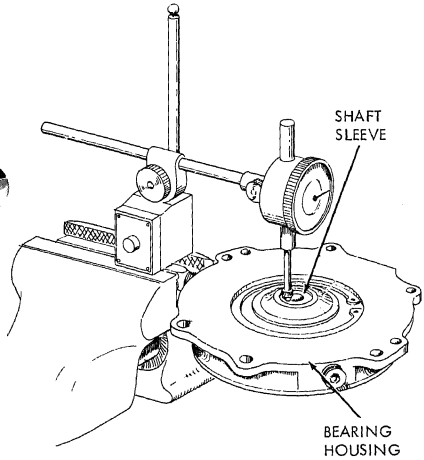
(7) Lubricate bearing (21, fig. 3–1) with engine oil (OE) and install mating ring (20) in bearing housing on bearing.

(8) Lubricate preformed packing (18, fig. 3–1) with engine oil (OE) and install in bearing housing.

(9) Position oil seal (16) squarely on bearing housing, with mating ring (20) held close to center of bearing (21) by lugs on the seal. Press parts into bearing housing (23) and install retaining ring (15).

(10) Check bearing clearance as follows:

(*a*) Slide mating ring (20, fig. 3–1) into center of bearing housing (23). Install turbine wheel (10), without oil seal (11) so that shaft extends through housing.



MEC 3805-239-35/3-5

Figure 3–5. Checking bearing clearance.

(*b*) Install shaft sleeve (19, fig. 3–1) on shaft. Position dial indicator with indicator point engaging top of shaft sleeve (fig. 3–5).

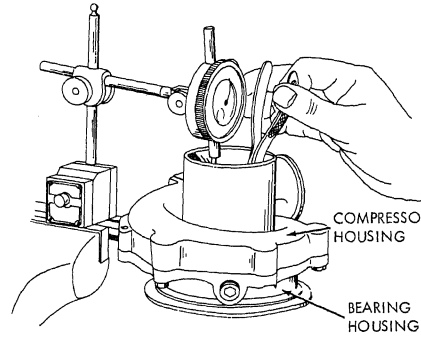
(*c*) Push up on turbine wheel (10, fig. 3–1) and check indicator reading. Clearance must be within 0.0010 to 0.0030 inch greater than bearing-to-turbine shaft clearance determined in figure 3–3. Remove turbine wheel and spacer.

(11) Determine impeller shim requirements as follows:

(*a*) Temporarily install shaft sleeve (19, fig. 3–1) in bore of oil seal (16). Position impeller (14) loosely over oil seal and resting on shaft sleeve. Install compressor housing (6) and gasket (7) on bearing housing (23) and secure with screws (5) in every other hole. Tighten screws to 80 inch-pounds torque.

(*b*) Mount a dial indicator with pointer engaging impeller hub as shown in figure 3–6. Using a pair of long nosed pliers, raise impeller as far as possible, check dial indicator to determine impeller movement.

(*c*) Subtract bearing-to-turbine shaft clearance determined in figure 3–3 from total impeller movement. Select shims which total 0.0150 to 0.0200 less than the value determined.



MEC 3805-239-35/3-6

Figure 3–6. Determining impeller shim requirements.

0.0490	reading just obtained
−0.0060	total clearance from step (13)
0.0430	difference
0.0430	difference
−0.0250	one 0.0100 shim plus one 0.0150 shim
0.0180	impeller to housing clearance.

(*d*) Remove screws, compressor housing, and impeller from bearing housing.

(12) Place bearing housing on level blocks

with turbine end upward. Install spring ring (13, fig. 3–1) into recess in housing. Position turbine shield (12) with lugs opposite flat areas of spring ring as shown in figure 3–7. Do not attempt to install shield with lugs engaging narrow spaces between spring projections.

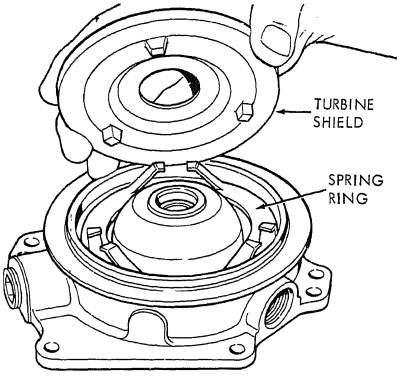


Figure 3–7. Installing turbine shield.

(13) Lubricate groove in turbine shaft with oil (OE). Install oil seal (11, fig. 3–1) on shaft. Check to see that mating ring (20) is centered in bearing housing (23). Install shaft of turbine wheel (10) into bearing housing. Oil seal (11) must be centered in shaft groove and in bore of housing.

(14) Invert the housing and install shaft sleeve (19) and shims (17) as determined above. Install impeller (14) on shaft and secure with nut (8) and washer (9). Hold turbine with a cloth or belt and tighten nut to 80–100 inch-pounds torque.

Note. Nut has left hand thread.

(15) Install assembled bearing housing on compressor housing (6) with gasket (17). Secure with screws (5). Tighten screws to 80 to 100 inch-pounds torque.

(16) Position gasket (4) on turbine housing (3). Install assembled turbocharger on turbine housing and secure with clamp (2). Tighten nut (1) to 15 to 20 inch-pounds torque.

(17) Rotate shaft to be sure all parts rotate freely in housings.

g. Installation.

(1) Refer to TM 5–3805–239–12 and install the turbocharger.

(2) Refer to TM 5–3805–239–12 and install the exhaust pipe and elbow on the turbocharger.

3–3. Intake Manifold

a. General. The air from the turbocharger compressor is forced into the intake manifold. Outlets from the manifold lead to each of the six cylinders. These outlets supply air to the combustion chambers in the cylinders through the intake valves.

b. Removal. Refer to TM 5–3805–239–12 and remove the intake manifold.

c. Cleaning. Clean intake manifold with cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

d. Inspection and Repair. Inspect intake manifold for cracks, elongated holes, and damage. Replace damaged manifolds.

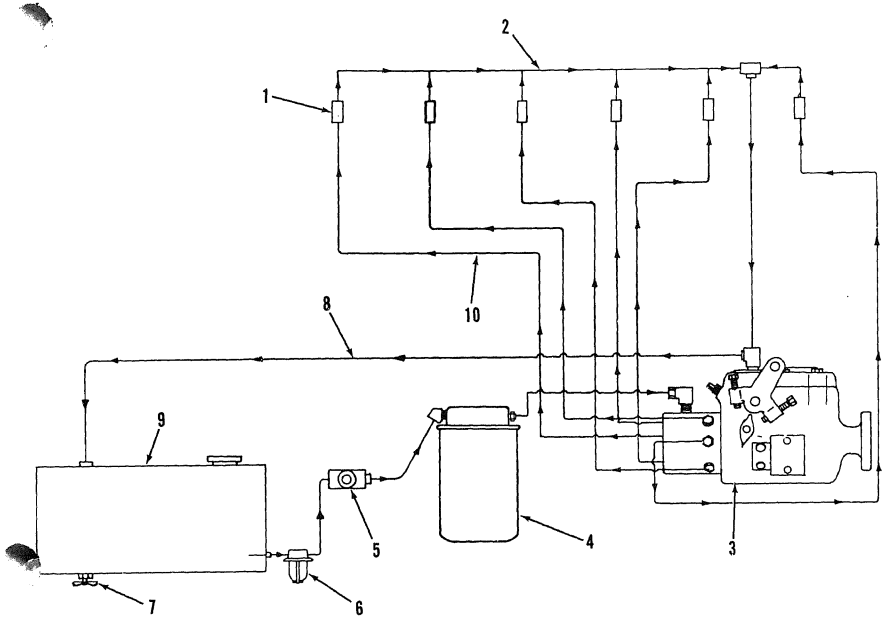
e. Installation. Refer to TM 5–3805–239–12 and install the intake manifold.

Section II. FUEL SYSTEM

3–4. General

a. The main components of the fuel system include the fuel tank, sediment bowl, hand primer pump, fuel filters, transfer pump, fuel injection pump, fuel injection nozzles, and the fuel lines.

b. Two systems comprise the overall fuel system for the engine. A low pressure system brings the fuel from the tank through the sediment bowl, primer pump, fuel filters, to the transfer pump and the return lines to the tank. The high pressure system includes the fuel



1 Fuel injection nozzle (6 rqr)
2 Fuel return manifold
3 Fuel injection pump
4 Combination fuel filter
5 Hand primer pump
6 Fuel sediment bowl
7 Fuel tank drain
8 Fuel return line
9 Fuel tank
10 Fuel injection lines (6 rqr)

MEC 3805-239-35/3-8

Figure 3–8. Fuel system schematic diagram.

injection pump, fuel lines to the injectors, and the injectors. Refer to figure 3–8 for a schematic diagram of the fuel system.

3–5. Fuel Lines

a. Removal. Refer to TM 5–3805–239–12 and remove the fuel lines.

b. Cleaning. Clean the fuel lines in cleaning compound solvent (Spec. P–S–661) and dry thoroughly with compressed air.

c. Inspection and Repair.

(1) Inspect fuel lines for kinks, cracks, and damage.

(2) Inspect nuts on fuel lines for damaged threads and cracks.

(3) Replace all damaged parts.

d. Installation. Refer to TM 5–3805–239–12 and install the fuel lines. Vent system as necessary.

3–6. Hand Primer Pump and Fuel Sediment Bowl

a. Removal. Refer to TM 5–3805–239–12 and remove the hand primer pump and fuel sediment bowl.

b. Disassembly. Refer to TM 5–3805–239–12 to disassemble the hand primer pump.

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

d. Inspection and Repair.

(1) Inspect sediment bowl for cracks and good gasket surfaces. Replace bowl if cracks or gasket surface is damaged.

(2) Inspect primer pump for wear on plunger and seals. Check spring for good condition.

(3) Replace all seals and gaskets. Replace all worn or damaged parts.

e. Assembly and Installation. Refer to TM 5–3805–239–12 to assemble and install the primer pump and sediment bowl.

3–7. Fuel Injection Pump

a. General.

(1) The fuel injection pump is a single cylinder, opposed plunger, inlet metering, distributor type. The pump plungers are operated by an internal cam ring. Fuel is accurately metered and delivered to the injectors under high pressure to be instantly atomized in the cylinders. The pump is timed to deliver the correct amount of fuel at the engine cylinder firing cycle and within the required injection period.

(2) A mechanical-centrifugal governor is an integral part of the pump. The governor controls fuel delivery and therefore engine speed. Drive for the governor is supplied by the pump drive shaft.

(3) A transfer pump, mounted on the front of the pump, draws fuel from the tank and delivers it to the injection pump. The transfer pump is of the positive displacement, vane type.

(4) Lubrication for the pump is supplied by the fuel oil. No other lubrication is required.

(5) A switch mounted on the top of the pump, controls fuel flow out of the pump. The switch actuates a solenoid, which when energized, opens the metering valve and allows fuel to flow from the pump to the engine. When the master switch on the instrument panel is placed in the off position, the solenoid closes the valve, ending fuel delivery and stopping the engine.

b. Removal.

(1) Clean outer surfaces of the pump and all fittings and lines at the pump.

(2) Rotate the engine flywheel to bring No. 1 piston near the top of the compression stroke and with the pointer on the timing gear cover (fig. 3–9) alined with the 24° BTDC mark on the pulley and damper assembly.

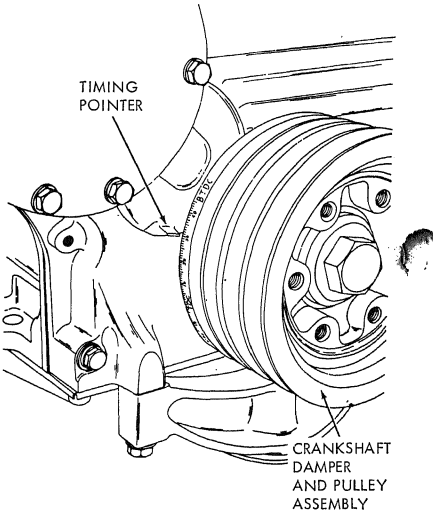
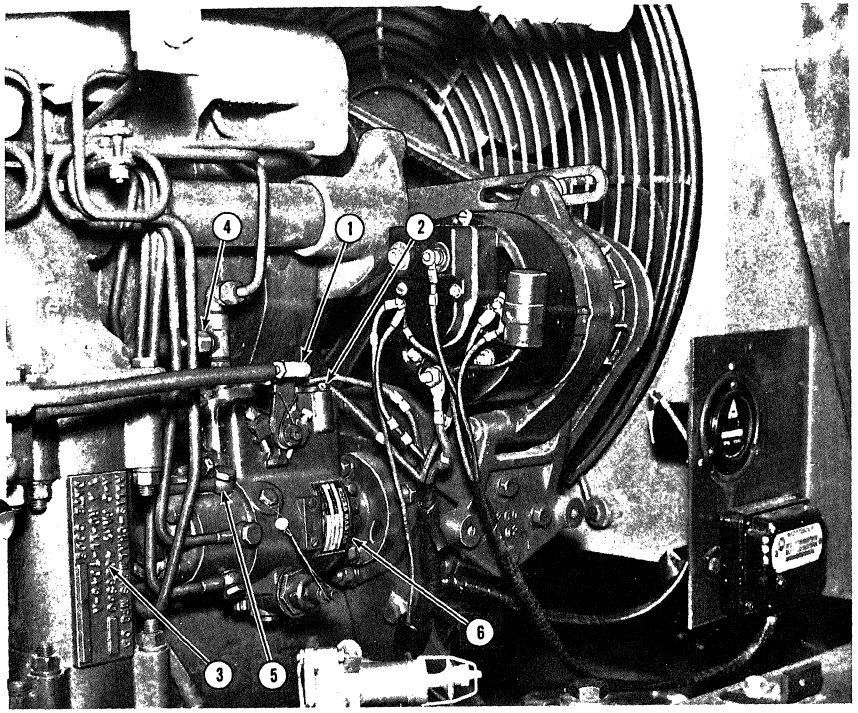


Figure 3–9. Pointer and timing marks.

(3) Refer to figure 3–10 and remove the fuel injection pump. Use care so as not to damage the drive shaft seals when removing pump.

c. Disassembly.

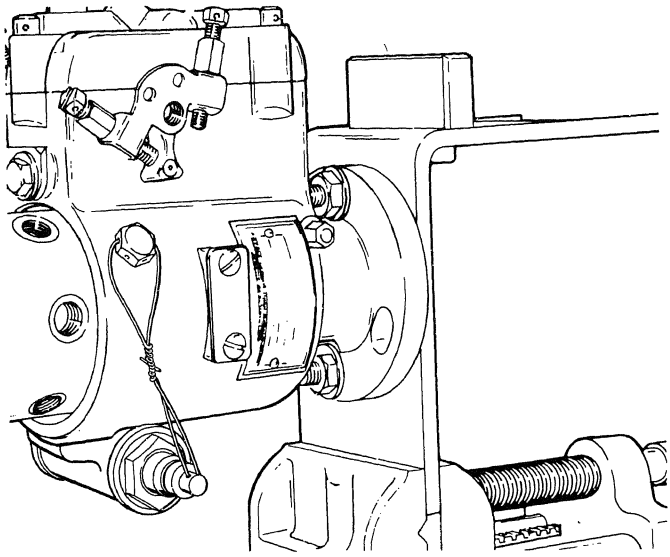
(1) Install the fuel injection pump in a suitable mounting fixture as illustrated in figure 3–11.



STEP 1. THROTTLE CONTROL. DISCONNECT THROTTLE ROD BALL JOINT FROM SPEED CONTROL LEVER.
STEP 2. SWITCH ELECTRICAL LEADS. DISCONNECT ELECTRICAL LEADS FROM FUEL SHUTOFF.
STEP 3. OIL COOLER. REFER TM 5-3805-239-12 AND REMOVE THE OIL COOLER.
STEP 4. FUEL RETURN LINES. DISCONNECT RETURN LINES FROM PUMP. TAPE OR COVER OPENINGS.
STEP 5. INJECTOR FUEL LINES. DISCONNECT SIX INJECTOR LINES FROM PUMP. TAPE OR COVER OPENINGS IN PUMP AND LINES. LOOSEN CLAMPS AND REMOVE LINES FROM INJECTORS AND ENGINE.
STEP 6. INJECTOR PUMP. REMOVE TWO NUTS AND SERRATED WASHERS SECURING PUMP TO STUDS. REMOVE PUMP ASSEMBLY FROM DRIVE SHAFT. BE CAREFUL NOT TO DAMAGE DRIVE SHAFT SEALS.

MEC 3805-239-35/3-10

Figure 3-10. Fuel injection pump, removal and installation.



MEC 3805-239-35/3-11

Figure 3–11. Injection pump mounted in fixture.

(2) Remove two screws (6, fig. 3–12) and remove cover (9) from pump.

(3) Remove shutoff cam (15), throttle lever (16), and associated parts from housing. Disassemble throttle lever (20), spring (19) and associated parts.

(4) Remove governor spring (31) and associated parts.

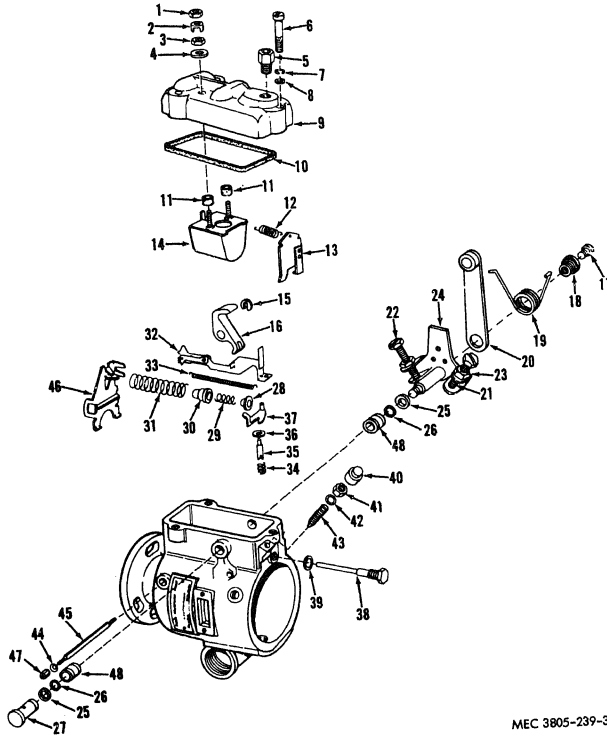
(5) Depress metering valve (35) and pull governor linkage hook (32) back to disengage it from governor arm (46). Lift linkage hook and spring from housing. Do not disengage spring.

(6) Remove metering valve (35) and associated parts.

(7) Remove nut (47), sealing washer (44) and pivot shaft (45). Remove governor arm (46) and linkage hook. Remove spring (33) from linkage hook.

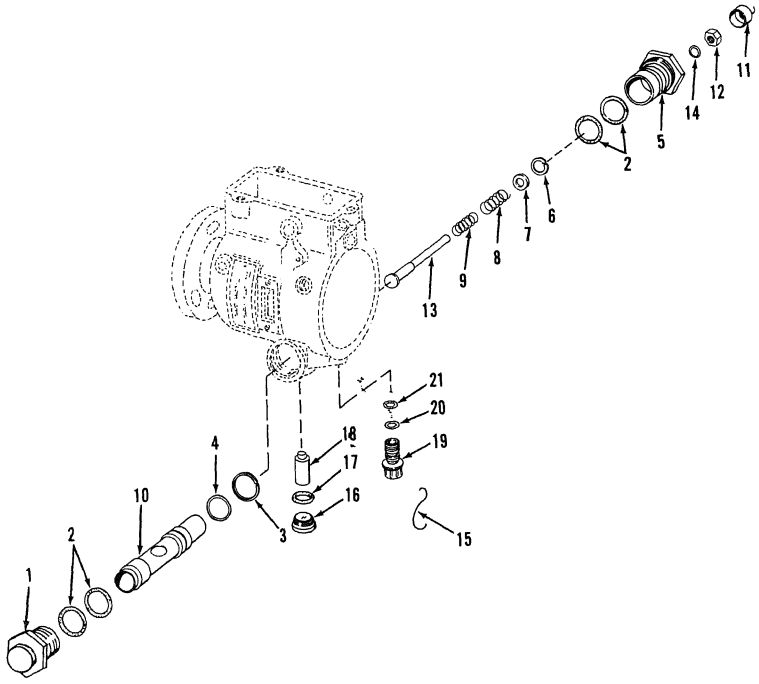
(8) Invert the holding fixture in the vise to bring automatic advance unit to the top.

(9) Remove access plug (16, fig. 3–13). It may be necessary to tap tool sharply to break threads loose. Remove packing (17). Use a throttle lever screw (21, fig. 3–12) as a puller screw and remove advance pin (18, fig. 3–13).



1 Terminal nut (2)
2 Grounding eyelet
3 Contact nut (2)
4 Insulating washer (2)
5 Tube fitting
6 Screw (2)
7 Washer, lock (2)
8 Washer, flat (2)
9 Governor control cover
10 Gasket
11 Insulator (2)
12 Arm spring
13 Shutoff arm (armature)
14 Coil
15 Shutoff cam
16 Throttle shaft lever
17 Screw
18 Spring retainer
19 Throttle lever spring
20 Throttle linkage lever
21 High idle adjusting screw
22 Low idle adjusting screw
23 Nut (2)
24 Throttle shaft
25 Washer (2)
26 Preformed packing (2)
27 Shutoff shaft
28 Spring guide
29 Idling spring
30 Spring retainer
31 Governor control spring
32 Governor linkage hook
33 Linkage spring
34 Metering valve spring
35 Metering valve
36 Valve shim
37 Valve arm
38 Guide stud
39 Guide washer
40 Cap
41 Lock nut
42 Seal
43 Torque screw
44 Seal washer (2)
45 Pivot shaft
46 Governor arm
47 Nut (2)
48 Shaft bearing (2)

Figure 3–12. Injection pump throttle lever and governor control, exploded view.



1 Piston hole plug
2 Preformed packing (4 rqr)
3 Piston ring
4 Preformed packing
5 Piston hole plug
6 Retaining ring
7 Flat washer
8 Inner spring
9 Outer spring
10 Advance piston
11 Screw cap
12 Lock nut
13 Advance screw
14 Preformed packing
15 Lock wire
16 Access plug
17 Preformed packing
18 Advance pin
19 Head locating screw
20 Preformed packing
21 Preformed packing

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Figure 3-13. Automatic advance components, exploded view.

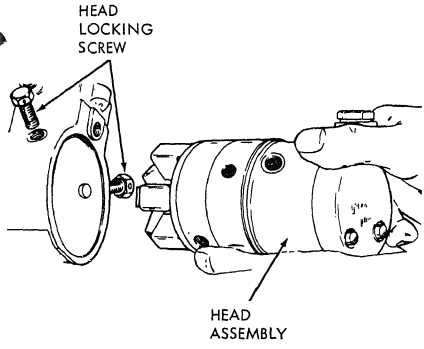


Figure 3–14. Removing head assembly.

(10) Remove wire (15, fig. 3–13) and remove cap (11), adjusting screw (13), nut (12) and packing (14). Remove plugs, piston, springs, and washers. Do not remove piston ring (3) from piston unless replacement is necessary.

(11) Remove head locating screw (19) and packings (20) and (21).

(12) Remove two head locking screws (fig. 3–14). Grasp head assembly firmly in both hands and withdraw head assembly from pump body using a slight rotary motion as illustrated in figure 3–14. Use care not to drop governor weights when head assembly is removed.

(13) Invert the head assembly and allow six governor weights (11, fig. 3–15), governor thrust sleeve (12) and thrust sleeve washer (13) drop into hand.

(14) Remove four screws (14) and remove end plate (17) and thrust plate (19). Remove sleeve (23) and associated parts from end plate. Press piston seal (28) from end plate.

(15) Remove four transfer pump blades (29), springs (30) and lever (32). Remove packing (18).

(16) Remove delivery valve screw (33) and shake head (40) to dislodge and remove stop (34), spring (35), and valve (36). Use an extractor to remove delivery valve if necessary.

(17) Use a small bladed screw driver or a dull scribe and remove retaining ring (38). Slide retainers (39) outward to clear rotor (52) and remove hydraulic head (40) from rotor. Remove retainers (39) from head (40).

(18) Remove cam ring (41) from rotor. Check roller-to-roller dimension as shown in figure 3–16. Apply clean dry air pressure (40 to 100 psi) to one of the head outlets as shown and check with a micrometer. Dimension from outside of one roller to outside of other roller should be 1.9640 to 1.9650 inches.

(19) Do not remove leaf springs (48, fig. 3–15) unless replacement is necessary. If springs are to be removed, mark them with a dye to be positioned correctly at assembly. Remove rollers (43), shoes (44), an plungers (45).

(20) Install head in a suitable support. Remove retaining ring (49). Press governor weight retainer (50) from rotor.

(21) Remove flexible retaining ring (51) from weight retainer with a retaining ring pliers. Place pliers between two rivets. Use a lifting twisting motion to lift ring from weight retainer. Repeat until ring is free. Discard flexible retaining ring.

d. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

e. Inspection and Repair.

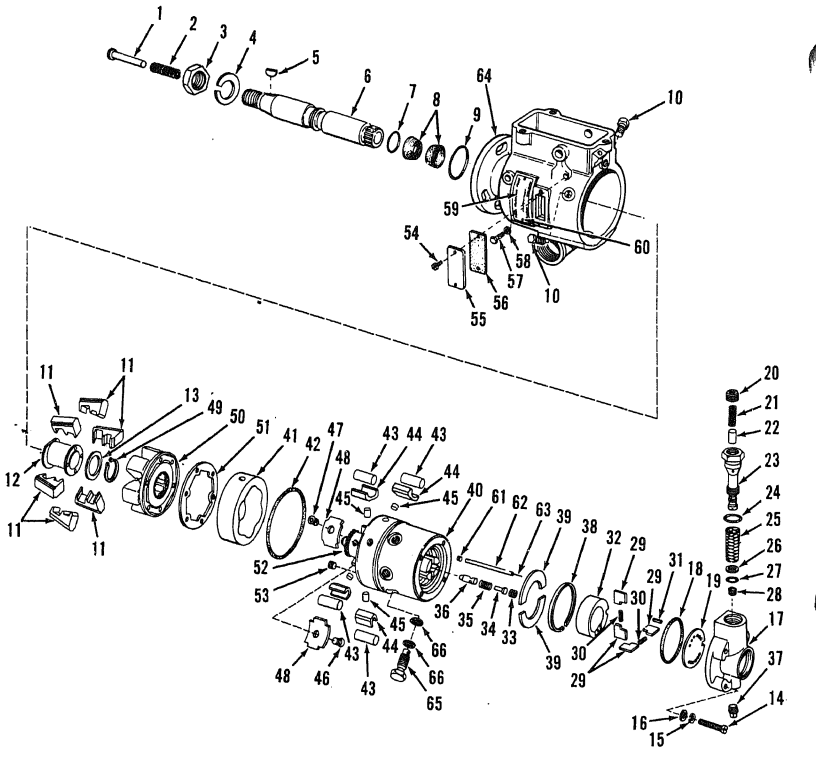
(1) Discard all seals, preformed packings, and gaskets.

(2) Inspect springs for distortion, breaks, and wear. Discard all unserviceable springs.

(3) Carefully check all bores, grooves, and seal seats for damage or wear. Replace damaged or worn parts.

(4) Inspect transfer pump blades for chipping, pitting and wear. Determine wear of blades by checking length of blade with a micrometer. Length must be 1.0920 to 1.9030 inches. Replace blades if worn or damaged. If one blade requires replacement, both blades must be replaced.

(5) Hold rotor under surface of tank of clean diesel fuel. Insert plungers in bores and check plungers for free movement. If plungers



1 Thrust button
2 Spring
3 Nut
4 Washer, lock
5 Shaft key
6 Drive shaft
7 Preformed packing
8 Shaft seal (2)
9 Preformed packing
10 Head locking screw (2)
11 Governor weight (6)
12 Governor thrust sleeve
13 Thrust washer
14 Screw (4)
15 Washer, lock (4)
16 Washer, flat (4)
17 End plate
18 Preformed packing
19 Thrust plate
20 Plug
21 Spring
22 Regulating piston
23 End plate sleeve
24 Preformed packing
25 Screen
26 Screen seal
27 Preformed packing
28 Piston seal
29 Pump blade (4)
30 Blade spring (2)
31 Locating pin
32 Pump lever
33 Delivery valve screw

Figure 3–15. Injection pump head and governor, exploded view.

34 Valve stop
35 Spring
36 Delivery valve
37 Pipe plug
38 Retaining ring
39 Rotor retainer (2)
40 Hydraulic head
41 Cam ring
42 Preformed packing
43 Roller (4)
44 Shoe (4)
45 Plunger (4)
46 Adjusting screw
47 Adjusting screw (polished)
48 Leaf spring (2)
49 Retaining ring
50 Weight retainer
51 Flexible ring
52 Rotor
53 Plug
54 Screw (2)
55 Timing line cover
56 Gasket
57 Torque screw hole plug
58 Washer
59 Screw (2)
60 Identification plate
61 Screw
62 Wire retainer
63 Vent wire
64 Pump body
65 Fuel line connection screw (6)
66 Washer, fuel line (12)

Figure 3-15—Continued.

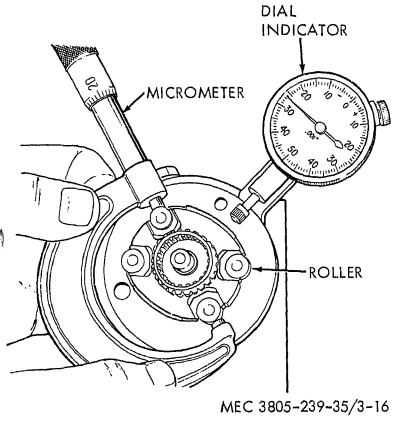


Figure 3-16. Checking roller-to-roller dimensions.

are damaged or sticking, replace plungers. Clean plungers with a lacquer-removing solvent if necessary.

(6) Inspect rotor and head for wear at leaf spring contact surfaces. Check drive spline for wear. Check slots, and ports for chipping or erosion. Check rotor shank for scratches and damage. Replace both rotor and head as a matched set if damaged parts are evident.

(7) Check vent wire for freedom of movement in head air bleed passage. If wire is free, flush head and blow out all passages with clean dry air. If wire is stuck, remove wire, clean passage and install new wire.

(8) Check each cam roller in shoe for freedom of movement. Inspect top of each shoe for chipping and wear. Replace rollers and shoes if worn or damaged.

(9) Check leaf springs for wear at rotor contact surfaces and shoe contact surfaces. Replace springs if worn.

(10) Check automatic advance bore for wear, rust, and damage. Inspect pistons and slide washers for wear and roughness. Inspect advance screw for wear. Remove high spots on piston ends and slide washers with a fine stone. Replace worn or damaged parts.

(11) Inspect governor weight retainer slots and pivot points for wear and damage. Retainer must be a press fit on rotor. If retainer is loose, replace retainer. Replace worn or damaged parts.

(12) Inspect pivot points on governor arm and pivot shaft for wear and damage. Inspect governor arm tips where tips contact thrust sleeve. If wear on tip is in excess of 0.0030 inch replace arm. Inspect metering valve pin hole in linkage hook, spring retainer, throttle shaft lever, shut-off cam, and the shaft assemblies for looseness and burs. Replace damaged or worn parts.

(13) Inspect metering valve body for wear. Valve arm must be well seated and leave no radial movement on the valve. Arm pin must not be worn or loose. Replace metering valve if parts do not meet inspection or show signs of wear or damage.

(14) Inspect inside diameter of cam and edges of all flat surfaces for evidence of flaking

or spalling. Inspect bore for advance pin for wear and damage. Replace cam if worn or damaged.

(15) Inspect drive shaft for wear and cracks. Check governor thrust sleeve surface for scoring. Check alinement of timing pin. Pin must be at 90° to key slot in shaft. Replace shaft if worn, damaged, or scored.

(16) Inspect regulating piston and bore in end plate for damage and wear and for freedom of piston movement in sleeve. Inspect threads for damage. Inspect screen for rust and damage. Do not remove liner locating pin unless replacement is necessary. Replace all worn or damaged parts.

(17) Inspect shutoff solenoid for cracks and damage. Inspect armature for damage. Check solenoid with an ohmmeter for complete circuit. Replace damaged or unserviceable parts.

f. Reassembly. Flush all parts in clean oil (OE). Do not wipe dry. Check torque values in paragraph 1–4. Use thread setting compound (gasket cement—MIL–C–10523(ORD) on each head plug screw before installation.

(1) If shaft bearings (48, fig. 3–12) were removed from housing, install new bearings. Ream holes with a four step reamer, starting reamer on throttle shaft side of housing and reaming through opposite side, with reamer passing through both holes. Ream dry. Using bearing screw and brace, install bearings in housing, using an adhesive (epoxytype) to seal bearings. Remove all excess adhesive before it hardens.

(2) Install plungers (45, fig. 3–15) into thin bores. Rinse rotor (52) in calibrating oil and install rotor in head (40).

(3) Place rotor and head in a suitable holding fixture and install leaf springs (48). Install rollers (43) and shoes (44). Check rollers for free movement.

Note. Rollers are marked with a number on the end (e.g. "–5", "–15", "–10" etc.). All rollers must be stamped with same numbers.

(4) Refer to figure 3–16 and *c* above and check roller-to-roller dimension. Set dimension by adjusting leaf springs (48) with adjusting screw (49).

(5) Check centrality of rollers. Rotate rotor until one roller is alined with dial indicator plunger. Slide indicator inward until plunger depresses 0.0100 inch. Lock indicator retaining screw. Zero indicator on high point of roller by rotating knurled dial. Rotate rotor until next roller depresses plunger. Allowable centrality is plus or minus 0.0020 inch (total 0.0040 inch). Check all rollers. Interchange rollers if necessary to meet tolerances.

Note. Shutoff air pressure before removing rollers to prevent plunger loss.

(6) Install cam ring (41, fig. 3–15) over rollers with arrow pointing in proper direction of pump rotation.

(7) Install flexible retaining ring (51) on governor weight retainer (50) using a snap ring pliers to expand holes in ring to fit over rivets.

(8) Establish governor weight retainer timing line as follows:

Note. Timing line must be established when installing a new retainer.

(*a*) Place original retainer on the graph (fig. 3–17) so that weight sockets and assembly marks are visible. Center retainer on outside diameter to obtain exact vertical and horizontal position. Aline drive socket and lugs (or center line of spline teeth) top and bottom to obtain exact radial position. Note position of timing line. Remove retainer from graph.

(*b*) Check timing code on rotor for the correction factor (fig. 3–18). If timing code is as indicated (T–2), weight timing line should be 2 degrees less than indicated by graph. If graph shows 260°, timing line actually will be 258°.

(*c*) Place new retainer on graph (fig. 3–17). Mark angle on retainer hub and etch mark for permanent identification.

(9) Install weight retainer on rotor with assembly mark in line with pin tang on rotor: Support hydraulic head so as not to damage rotor. Use a suitable tool and spacer to press retainer on rotor spline until retainer bottoms.

(10) Install two rotor retainers (39, fig. 3–15) and retaining ring (38).

(11) Install delivery valve (36), making sure it operates freely in bore. Install spring (35) and stop (34). Install screw (33) and torque screw to 85–90 inch-pounds.

(12) Install transfer pump lever (32) with large slot in lever in line with head locating screw hole and letter "c" facing up. Install transfer pump blades (29) and springs (30).

(13) Assemble end plate.

(*a*) Press new piston seal (28) in until

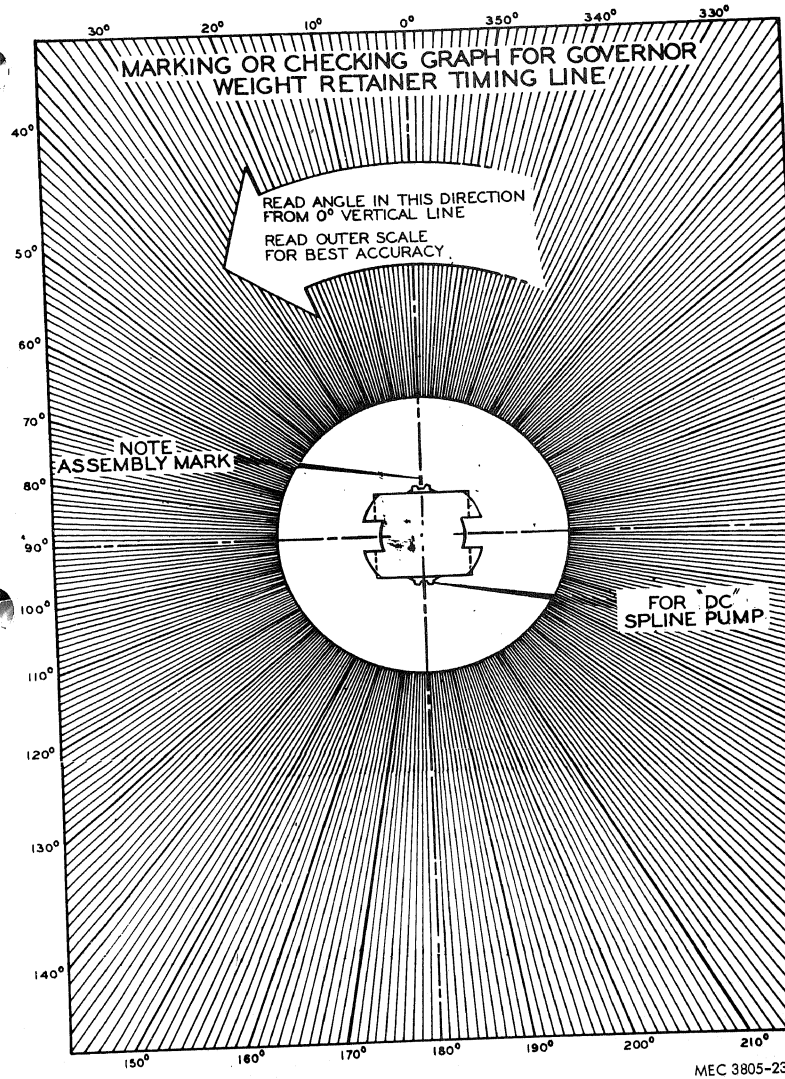
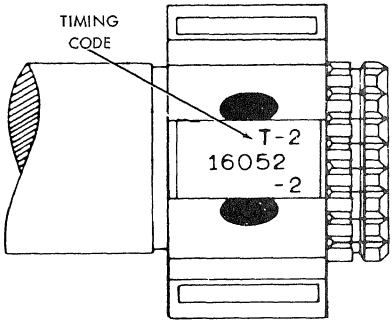


Figure 3–17. Weight retainer timing line checking graph.



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Figure 3–18. Timing code on rotor.

flange is seated against bottom of end plate sleeve (23). Rinse parts in clean oil (OE) and install piston (22) and spring (21) in sleeve. Piston must slide in bore without binding.

(*b*) Install adjusting plug (20) turning plug in until threads are below port "A".

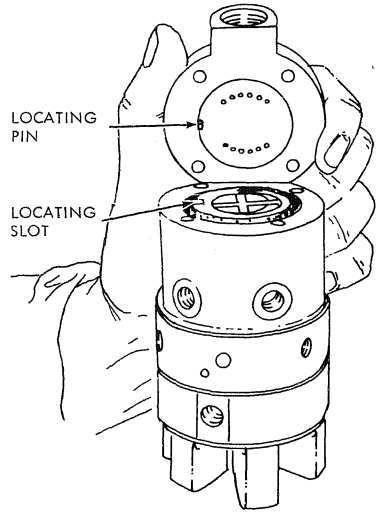
Note. Check for tightness of orifice plate and replace plug if plate is loose.

(*c*) Install screen and seals on sleeve. Install assembled sleeve in end plate (17).

(*d*) Install thrust plate (19) on end plate. Use a small amount of grease to hold thrust plate on end plate.

(14) Install end plate and preformed packing (18) on pump and secure with screws (14). Torque screws to 25 to 30 inch-pounds. Locate end plate on head as shown in figure 3–19, with locating pin in line with locating slot as illustrated, when installing end plate.

(15) Place head and rotor assembly in the holding fixture with drive end up. Install governor weights (11, fig. 3–15) in retainer and install thrust washer (13) and thrust sleeve (12) into lower slots in weights by tipping weights back slightly. Chamfered edge of thrust washer must face upward against circular end of thrust sleeve. After installation, weights should all be level and collapsed against sleeve.



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Figure 3–19. Installing end plate.

(16) Place the governor arm (46, fig. 3–12) with fork for governor linkage hook facing the end plate. Install pivot shaft (45), with knife edge facing end plate, through arm and body. Secure shaft with seals (44) and nuts (47). Tighten nuts to 20–25 inch-pounds.

(17) Install assembled hydraulic head in housing, using new preformed packing (47, fig. 3–15).

(18) Coat packings (20 and 21, fig. 3–13) with grease and install head locating screw (19) and torque to 300 inch-pounds. Install two head locating screws (10, fig. 3–15) and torque to 300 inch-pounds.

(19) Check cam for freedom of movement. If cam sticks, tap cam to loosen and retorque screws.

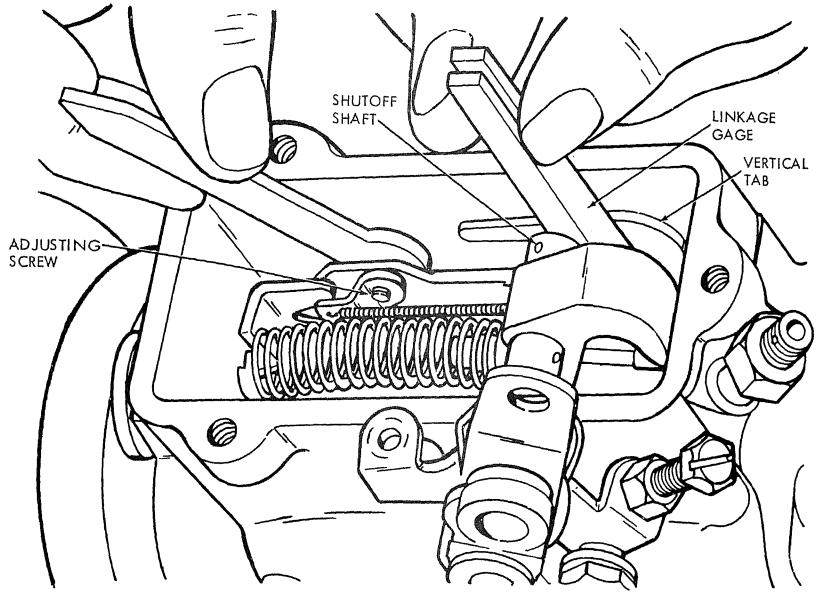


Figure 3–20. Checking shaft clearance.

(20) Install piston ring (3, fig. 3–13) and packing (4) on piston (10). Install advance screw (13), springs (8 and 9), flat washer (7) and retaining ring (6) in piston. Use piston ring compressor to install piston ring on piston. Install packings (2) on plug (5) and install plug on advance screw. Turn screw out until ½ inch extends from plug.

(21) Install packings (2) on plug (1). Install piston and aline pin hole in advance piston with unthreaded hole in cam and install advance pin (18), ball end first, into hole. Secure pin with plug (16) and packing (17). Install plug (1) on housing. Tighten both plugs.

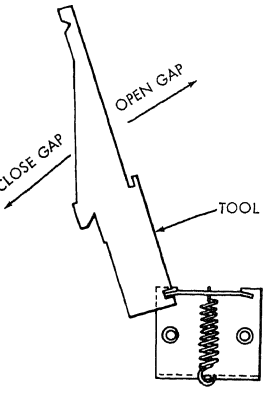
(22) Install packing (14), screw (13), nut (12) and cap (11) on advance screw and plug.

(23) Install shim (36, fig. 3–12) on metering valve arm (37). Install spring (34) on valve and install valve in bore in body. Valve must move free in bore.

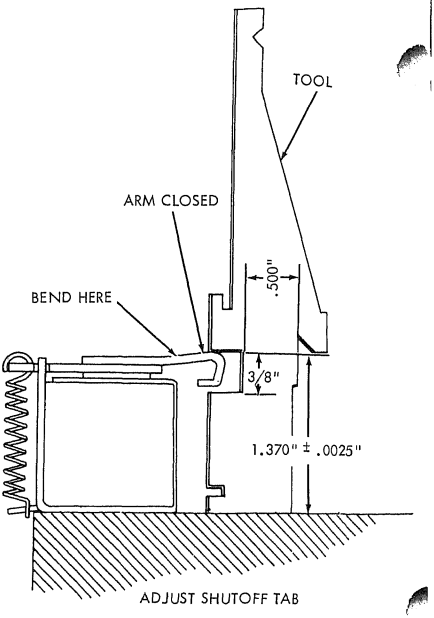
(24) Install spring (33) on governor linkage hook (32). Install hook on governor arm in housing and position opposite end of hook over pin on metering valve arm. Check all parts for freedom of movement.

(25) Assemble governor spring (31), spring retainer (30) idling spring (29), and spring guide (28). Hold parts together between thumb and forefinger and engage governor spring over formed tabs of governor arm. Install guide washer (39) on guide stud (38) and install stud through spring parts and tighten stud to specified torque.

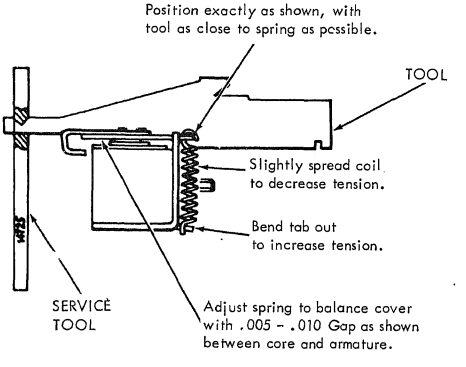
(26) Assemble throttle shaft and lever parts (17 through 26) and install shaft partially through bore in housing. Slide throttle shaft lever (16) over throttle shaft with projection in bore of shaft lever engaging rear keyway on shaft and forked end of lever straddling guide stud.



ADJUST ARMATURE TRAVEL



ADJUST SHUTOFF TAB



ADJUST SPRING TENSION

MEC 3805-239-35/3-21

Figure 3-21. Adjusting fuel shutoff switch.

(27) Apply a light coat of grease (GAA) packings (26) and install shutoff shaft (27) om opposite side of housing. Install shutoff n (15) with the straight inner edge of cam gaging slot in shaft. Cam should snap firmly o position.

(28) Install torque screw (43), packing 2) and nut (41) in housing.

(29) Adjust throttle linkage clearance.

(*a*) Hold throttle linkage lever (20) in wide open position. Back out torque screw 3).

(*b*) Install linkage gage—13389 4760) as shown in figure 3–20.

(*c*) Tighten adjusting screw (fig. 3–20) l apply a light pressure at vertical tab (fig. 20). Rotate pump shaft several times to as- e that linkage is in full forward position.

(*d*) Loosen adjusting screw and slide kage to maximum open position. Insert all end of gage between vertical tab and itoff shaft (fig. 3–20). Slide linkage hook to- ther from the rear until face of tab is flush ainst gage. Tighten adjusting screw. Remove ge. Check adjustment after tightening. Reset necessary.

(30) Check all governor parts for freedom movement.

(31) Install shutoff arm (13, fig. 3–12) and ring (12) on coil (14). Adjust arm coil and ring tension as illustrated on figure 3–20.

(32) Install insulators (11, fig. 3–12) on terminal screws and install gasket (10) and cover (9) on pump.

(33) Install attaching parts to hold cover on pump.

g. Test Stand Data. The test stand should be an American-Bosch TSE 4500 or its equivalent. The following are pertinent facts relating to testing and test stands.

(1) Engine firing order is 1–5–3–6–2–4.

(2) Pump rotation is clockwise when viewed from the drive end and is timed to the engine at 24° BTDC (static).

(3) Altitude adjustment is a derating of 3 percent of maximum fuel delivery for every 1000 feet of altitude above maximum altitude specified for satisfactory operation with factory settings (8000 feet).

(4) Maximum vacuum on the transfer pump is 15 to 25 inches of mercury.

(5) Roller-to-roller dimensions have a tolerance of ± 0.0050 inch.

(6) Test stand injection nozzles are to be set at 2500 psi.

(7) Calibrating oil is to be American-Bosch TSE 76141, Roosa Master 15816 or their equivalent (34–36 SSU at 100° F). Temperature of oil must be maintained at 110 to 115° F.

(8) All test stand data is in rpm unless otherwise specified. Table 3–1 shows data applicable to the injection pump.

Table 3–1. Test Stand Data

RPM (pump)	Adjustment	cc/minutes 100 strokes	Transfer pump pressure (approximate psi)
600	Roller-to-roller (1.9640 to 1.9500 in.)	54–56	43–49 72–78
1100	Torque screw	47.5–48.5	
75	Minimum flow	30	8 (minimum)

(9) Engine speeds are as follows:

(*a*) High idle—2375—2425 rpm

(*b*) Low idle—650—700 rpm

(*c*) Full load—2200 rpm (197 hp. obs.)

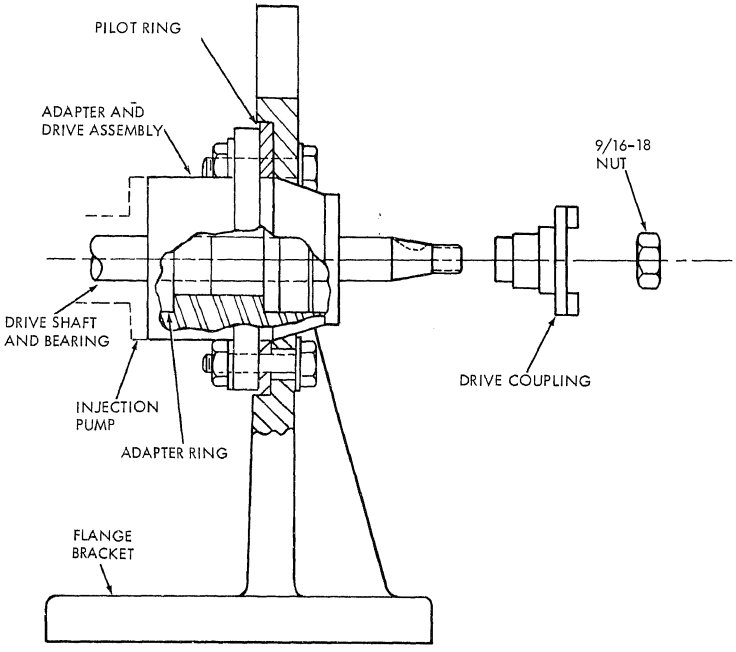
h. Bench Test Procedure. After rebuild and assembly of the injection pump it must be installed in a test stand and tested and adjusted. he following procedure applies to the pump ed with the loader engine.

(1) Refer to figure 3–22 and install injection pump in flange bracket and adapter.

Note. Install timing window on pump.

(2) Slide pump and bracket on rails of test stand to engage drive coupling with test stand drive disk. Allow 1/64 inch clearance between drive coupling and disk.

(3) Secure flange bracket to test stand



STEP 1. INSTALL FLANGE BRACKET ON TEST STAND.
STEP 2. REMOVE WIRE FROM ADAPTER AND DRIVE ASSEMBLY AND INSTALL DRIVE SHAFT AND BEARING INTO ADAPTER. INSTALL WIRE TO RETAIN BEARING.
STEP 3. INSTALL PILOT RING AND ADAPTER INTO FLANGE BRACKET AND SECURE WITH ADAPTER SCREWS AND NUTS.
STEP 4. INSTALL ADAPTER RING INTO RECESS IN ADAPTER ASSEMBLY.
STEP 5. INSTALL DRIVE COUPLING ON SHAFT AND SECURE WITH 9/16-18 NUT.
STEP 6. INSTALL PUMP IN ADAPTER AND SECURE WITH SCREWS SUPPLIED. ENGAGE SHAFT IN PUMP SPLINES.

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Figure 3-22. Installing or removing injection pump from flange bracket.

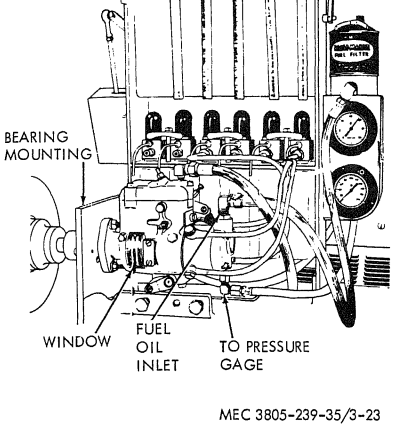


Figure 3–23. Typical fuel injection pump mounted on test stand.

(4) Connect high pressure injection lines to head assembly, using new gaskets. Do not tighten screws on connectors. Leave injection line nuts at nozzles loose. Loosen if necessary. Install inlet and return fuel lines and transfer pump pressure gage.

(5) Set counter and tachometer switches to "clockwise" position. Test stand tachometer registers pump speed (rpm).

(6) Start test stand at lowest speed. Move throttle slowly to "full-load" position. As transfer pump picks up suction allow fuel to bleed for several seconds from loosened head and injector connections. Tighten screws and nuts securely.

(7) Operate pump at 1000 rpm for 10 minutes. Stop test stand and dry pump off completely with compressed air. Start test stand and observe pump and all connections for leaks. Back out high idle screw (fig. 3–24) and torque screw.

Note. The inlet to the transfer pump must never be pressurized during bench testing.

(8) Test transfer pump suction.

(*a*) Close valve in supply line to pump. Operate test stand at 400 rpm (engine speed). reach this point, check for air leaks on suction side or malfunction in transfer pump ports.

(*c*) Open valve in supply line.

(9) Fill graduates to bleed air from test stand and lines and to wet glass.

(10) Observe return oil. Return should be at rate of 100 to 450 cc/minute (cubic centimeters per minute) at 35 psi transfer pump pressure.

(11) Operate at specified speeds (75, 600, and 1100 rpm pump speed) with wide open throttle and observe transfer pump pressure. Adjust transfer pump pressure regulating plug (fig. 3–24) to raise or lower transfer pump pressure to values given in table 3–1.

Caution: **Under no circumstances must 130 psi be exceeded. Damage to the pump could result.**

(12) Check for minimum delivery at cranking speed.

(13) Operate pump at high idle speed (2375—2425 rpm) and adjust high idle screw (fig. 3–24) to obtain 20–25 percent of full load fuel delivery (approximately 12cc/500 strokes).

(14) Adjust the low idle screw (fig. 3–24) to provide a fuel delivery at low idle speed of 10–12 cc/500 strokes.

(15) Adjust speed advance.

(*a*) Check the cam position at specified points in the speed range. The automatic advance should provide full retard at low idle; 4 degrees pump (8 degrees engine advance) at 800 pump rpm; and 6 degrees pump (12 degrees engine) at 900 pump rpm.

(*b*) Adjust speed advance adjusting screw (fig. 3–24)to obtain proper advance operation. Each mark on the timing window (fig. 3–25) is 2 pump degrees (4 engine degrees).

(16) Record fuel delivery at check points shown in table 3–1. Do not readjust roller settings. Micrometer settings made during reassembly provide more consistent, accurate results.

(17) Operate test stand at full load governed speed and adjust torque screw (fig. 3–24) to obtain specified delivery (47.5 to 48.5 cc/500 strokes.)

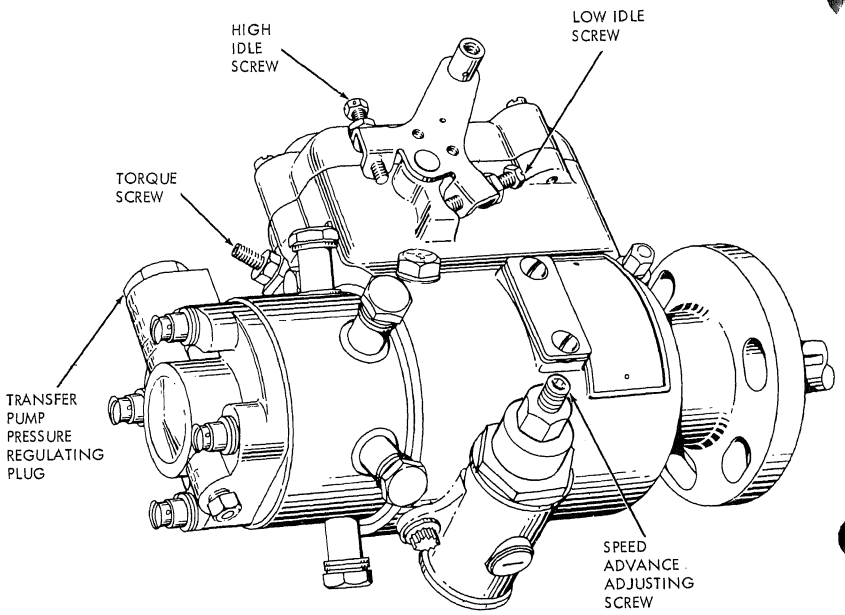


Figure 3–24. Injection pump adjustment points.

(18) Operate test stand at lowest speed. Check point and recheck delivery.

(19) Check governor cutoff at specified speed (high idle).

(20) Remove pump from test stand and refer to figure 3–22 to remove pump and adapter from flange bracket.

(21) Attach all sealing wires and plug all openings.

i. Installation. Refer to figure 3–11 and *b* above and reverse the procedures to install the injector pump on the engine.

(1) Remove the rocker arm cover (para 3–9).

(2) Crank engine by hand until No. 6 cylinder exhaust valve is nearly closed and No. 6 cylinder intake valve is just starting to open. This will position No. 1 piston near the top of compression stroke.

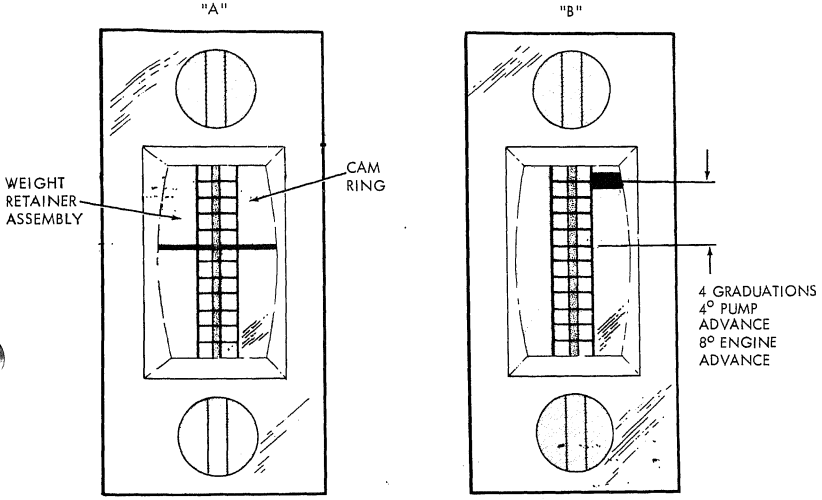
(3) Continue rotating the flywheel until timing pointer (fig. 3–9) indicates 24° BTDC.

(4) Inspect seals on pump drive shaft and replace if damaged. Lubricate seals with engine oil (OE). Slide the injector pump (fig. 3–10) over drive shaft with care to prevent damage to seals.

(5) Install nuts and washers but do not tighten. Rotate pump until timing marks are alined. Tighten nuts to 19 to 22 foot-pounds.

(6) Refer to figure 3–10 to complete installation.

NOTE: EACH GRADUATION EQUALS 2 DEGREES PUMP ADVANCE OR 4 DEGREES ENGINE ADVANCE



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Figure 3-25. Checking timing mark advance.

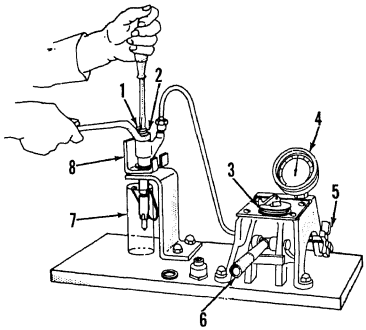
3–8. Injection Nozzle

a. General. Each cylinder is supplied with fuel through an injection nozzle. The high pressure fuel enters through the nozzle ports and is atomized instantly within the cylinder to combine with the air to provide the explosive mixture. The nozzle consists of a nozzle assembly and a holder assembly. The nozzle is positioned on the holder by two dowels to bring the spray ports on a plane parallel to the top of the piston.

b. Removal. Refer to TM 5–3805–239–12 and remove the fuel injection nozzles from the engine.

c. Testing.

(1) Install the nozzle in a test stand similar to the one shown in figure 3–26.



1 Pressure Adjusting Screw
2 Adjusting Screw Locknut
3 Filler Cap
4 Pressure Gage
5 Valve Handle
6 Tester Handle
7 Spray Collector
8 Nozzle-Holder Assembly

MEC 3805-239-35/3-26

Figure 3–26. Fuel injection nozzle tester

(2) Turn valve handle (fig. 3–26) to open position. Loosen tester filler cap to prevent an air lock. Pump tester handle until fuel flows from end of fuel line. Close tester valve.

(3) Install nozzle in tester and install spray collector over nozzle end of injection nozzle.

(4) Operate tester handle a few quick strokes and observe popping pressure of the nozzle. Pressure should be 2900 psi. New production nozzle holders are set at 3100 to 3150 psi to compensate for the spindle spring.

(5) Adjust nozzle pressure as follows:

(*a*) Remove cap nut from upper end of nozzle and loosen lock nut (fig. 3–26).

(*b*) While operating tester handle turn pressure adjusting screw (fig. 3–26) in to increase and out to decrease pressure until specified pressure is obtained. Hold adjusting screw and tighten lock nut to 75 to 90 pound-feet.

(6) Check nozzle for leakage as follows:

(*a*) Dry the tip of the nozzle.

(*b*) Operate tester handle slowly until pressure is approximately 200 psi below popping pressure.

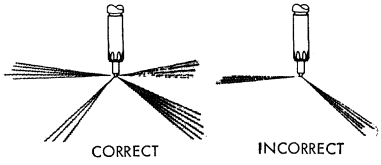
(*c*) Check nozzle for leakage. If oil drips from nozzle, injection nozzle must be disassembled and repaired.

(7) Check nozzle spray pattern as follows:

(*a*) If nozzle does not leak, check spray pattern.

(*b*) Operate handle at 100 strokes per minute.

(*c*) Observe spray pattern. Nozzle has four equally spaced holes. If fuel is delivered equally the spray pattern should be as illustrated on figure 3–27.



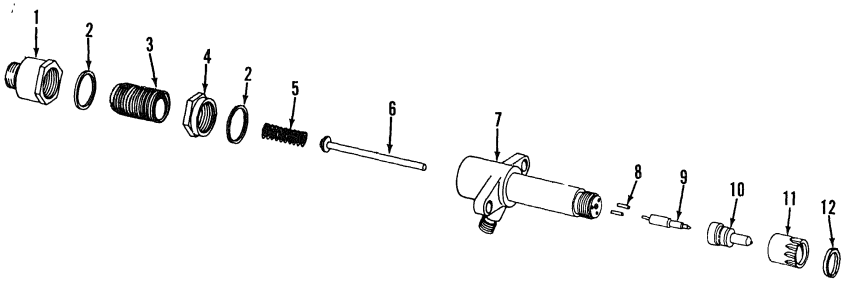
MEC 3805-239-35/3-27

Figure 3–27. Nozzle spray patterns

(*d*) If spray pattern is not correct, clean spray holes. The holes are 0.0126 inch in diameter.

d. Disassembly.

(1) Clean the nozzle and holder thoroughly.



1 Cap nut
2 Gasket (2 rqr)
3 Adjusting screw
4 Lock nut
5 Spindle spring
6 Spindle
7 Holder
8 Dowel pin (2 rqr)
9 Valve
10 Valve body
11 Nozzle retaining nut
12 Gasket

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Figure 3–28. Fuel injection nozzle and holder, exploded view.

(2) Clamp nozzle and holder in a holding fixture.

(3) Remove cap (1, fig. 3–28) and gasket (2) from nozzle holder (7).

(4) Remove lock nut (4), adjusting screw (3), gasket (2), spindle spring (5), and spindle (6) from holder (7).

(5) Remove nut (11) and valve (9) and valve body (10) from holder body.

e. Cleaning. Place valve and valve body in carbon removing compound (MIL–S–12382 (ORD) type I). Heat compound to 200° F for better results. After a few minutes, place parts in clean diesel fuel. Clean all other parts in diesel fuel.

***Warning:* Do not allow carbon removing compound to contact skin, use goggles, rubber gloves, and apron when using compound. If splashed on the skin, clean immediately with fresh water and wash with alcohol.**

f. Inspection and Repair

(1) Inspect seat in valve body with a magnifying glass. Inspect lapped bore in body for scoring. If valve or valve body are worn or damaged both must be replaced as a set. Clean outer surfaces of valve body with a brass brush. Do not scrape carbon from around orifices in tip with any hard object.

(2) Clean orifices in tip with 0.01260 inch diameter wire.

(3) Inspect lapped surface of valve. Surface must be smooth and free of scoring. Seat must not show any wear or damage. Replace both valve and valve body if valve is damaged.

(4) After cleaning and rinsing in diesel fuel, fit valve in valve body. Valve must move free in body. Lift valve about one-third of the way from body. Valve should slide down to its seat when held at a 45° angle.

(5) Flat sealing surface of valve body can be lapped to remove scratches. Remove all traces of lapping compound after lapping.

(6) Inspect flat sealing surface in holder body for scoring or scratches. Lap surface to remove scratches. Keep body square with lapping block when lapping. Remove all lapping compound after lapping. Inspect dowel pins for good condition.

(7) Inspect all parts for damage. Inspect threads for broken or damaged threads. Inspect spindle spring for cracks, scratches, and pitting. Inspect ends of spring for wear. Replace all worn or damaged parts.

g. Reassembly. Refer to figure 3–28 and reassemble the fuel injection nozzle and holder.

(1) Install spindle (6), spring (5), pressure adjusting screw (3) and lock nut (4) on holder (7), using a new gasket (2). Install cap nut (1) and new gasket. Do not tighten.

(2) Install nozzle valve (9), valve body (10) and nut (11). Tighten nut to 40 to 60 foot-pounds.

(3) Test and adjust nozzle and holder as described in *c* above. Tighten cap nut to 75 to 90 foot-pounds.

h. Installation. Clean carbon from nozzle bore in cylinder head (para 3–23) before installing nozzle and holder. Refer to TM 5–3805–239–12 and install nozzle and holder and fuel lines on engine.

Section III. EXHAUST SYSTEM

3–9. General

a. Exhaust gases pass from the cylinders through the exhaust valve ports. From there they enter the exhaust manifold and flow through the outlet into the turbocharger turbine housing.

b. As the gases pass through the turbine housing they rotate the turbine and compressor. The compressor forces air into the intake manifold under pressure.

c. From the turbine housing the gases pass up through the exhaust pipe and are expelled to the atmosphere.

3–10. Exhaust Manifold

a. Removal. Refer to TM 5–3805–239–12 and remove the exhaust manifold. Discard gaskets.

b. Cleaning. Clean exhaust manifold in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air. Clean carbon deposits from manifolds.

c. Inspection and Repair. Inspect manifold for evidence of leakage, cracks, and other damage. Inspect mounting surfaces for warpage. Machine surfaces if possible. Remove same amount of stock from all manifolds if machining is necessary. Replace damaged or cracked manifolds.

d. Installation. Use new gaskets and refer to TM 5–3805–239–12 to install the exhaust manifolds.

3–11. Exhaust Pipe

a. Removal. Refer to TM 5–3805–239–12 and remove the exhaust pipe.

b. Cleaning. Clean exhaust pipe in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air. Clean carbon deposits from exhaust pipe.

c. Inspection and Repair. Inspect exhaust pipe for cracks and evidence of leakage. Inspect cap for good condition. Replace damaged or leaking parts.

d. Installation. Refer to TM 5–3805–239–12 and install the exhaust pipe.

Section IV. COOLING SYSTEM

3–12. General

a. The cooling system consists of the water pump, radiator, piping, thermostat and housing, oil cooler, cooling fan, and the water passages in the cylinder block and cylinder head.

b. Coolant is drawn from the radiator by the water pump and pumped through the oil cooler into the engine block. The coolant flows through the engine block and out through the thermostat housing and returns to the radiator. A portion of the coolant is diverted from the thermostat housing to cool the air compressor.

3–13. Radiator, Fan, and Thermostat

a. Removal. Refer to TM 5–3805–239–12 to remove the radiator, fan, and thermostat.

b. Cleaning.

(1) Clean all foreign material from exterior of radiator and radiator cooling cores and fins.

(2) Refer to TM 9–2858 for cleaning and flushing procedures for the radiator.

c. Inspection and Repair.

(1) Inspect radiator for clogging or leaking. Test radiator under water with 4 to 5 pounds of air pressure. Solder all leaks.

Note. The radiator should be repaired only by authorized personnel.

(2) Replace damaged radiators.

(3) Refer to TM 5–3805–239–12 for thermostat testing and inspection.

(4) Inspect fan for bent or damaged blades. Repair blades or replace a damaged fan.

d. Installation. Refer to TM 5–3805–239–12 and install radiator, fan, and thermostat.

3–14. Oil Cooler

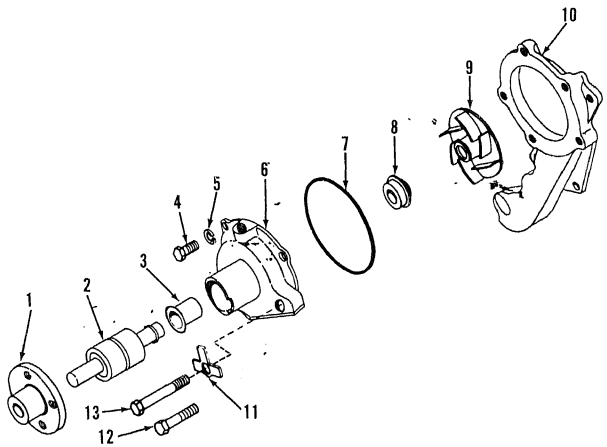
a. Removal. Refer to TM 5–3805–239–12 and remove the oil cooler.

b. Cleaning. Clean interior and exterior of oil cooler with trichloroethylene (Spec O–T–634 type II). Rinse thoroughly with clear water.

Warning: **The solvent fumes are highly toxic and volatile. Use only in a well ventilated area. Do not breathe fumes for extended periods.**

c. Inspection and Repair.

(1) Make two suitable improvised plates one with an air hose fitting, and secure them with C clamps to cover oil inlet and outlet openings. Seal plates with preformed packings



1 Pulley hub
2 Shaft and bearing
3 Water deflector
4 Screw, cap, hex-head, 3/8-16 x 1-1/8 in. (3 rqr)
5 Washer, lock, 3/8 in. (3 rqr)
6 Pump body
7 Preformed packing
8 Seal assembly
9 Impeller
10 Water outlet volute
11 Washer, tab (2 rqr)
12 Screw, cap, hex-head, 3/8-16 x 2 in.
13 Screw, cap, hex-head, 3/8-16 x 3-1/4 in.

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Figure 3–29. Water pump, exploded view.

(2) Attach an air hose to the fitting and submerge the oil cooler in hot water to bring oil cooler to approximately 150° F temperature. Test for leaks with 200 psi air pressure.

(3) Air bubbles observed at either open end of the oil cooler indicates cooling core is punctured. If core is punctured, replace oil cooler. If tank leaks, refer to TM 9–2858 for repair procedures.

(4) Replace damaged oil coolers.

d. Installation. Refer to TM 5–3805–239–12 and install the oil cooler.

3–15. Water Pump

a. Removal. Refer to TM 5–3805–239–12 and remove the water pump.

b. Disassembly. Refer to figure 3–29 and the following instructions and disassemble the water pump.

(1) Press pully hub (1, fig. 3–29) from shaft.

(2) Press shaft and bearing (2) from pump body (6).

(3) Remove impeller (9) from body.

(4) Drive seal assembly (8) from body. Discard seal assembly.

c. Cleaning. Clean metal parts, except shaft and bearing, in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air. Clean pump body in trichloroethylene (Spec. O–T–634, type II).

Warning: **The solvent fumes are highly toxic and volatile. Use only in a well ventilated area. Do not breathe fumes for extended periods.**

d. Inspection and Repair.

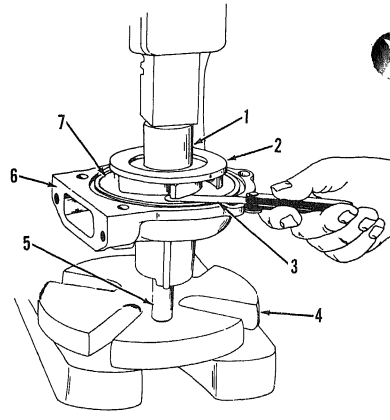
(1) Rotate bearing on bearing and shaft assembly. Bearing must rotate freely. If bearing binds, replace bearing and shaft assembly.

(2) Check deflector for damage. If deflector is damaged replace the deflector.

(3) Inspect impeller for damage to blades. Check ceramic insert on impeller for cracks, chipped areas, and damage. Replace damaged impellers.

(4) Check bearing bore in pump body. Replace body if bore is damaged.

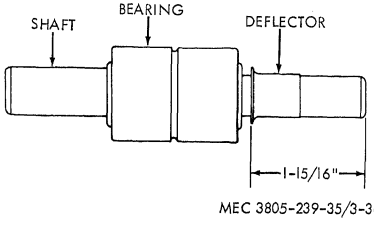
(5) Check water outlet volute for cracks and damage. Replace volute if damaged.



1 Collar
2 Impeller
3 Feeler Gage
4 Press Base Plate
5 Shaft
6 Water Pump Body
7 Body Plate

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Figure 3–31. Installing impeller and checking clearance.



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Figure 3–30. Deflector installed on bearing and shaft assembly.

e. Reassembly. Refer to figure 3–29 and the following instructions and reassemble the water pump.

(1) Apply compound sealer, Permatex to seal assembly (8) surfaces that are pressed into pump body. Position seal assembly in body and, using a suitable installing tool, press seal assembly into pump body. Do not damage carbon sealing surface. The face of seal assembly must be free of oil, grease, and finger prints before installation.

(2) If deflector (3) was removed from shaft, position deflector on shaft as shown in figure 3–30. Press deflector on shaft, using a suitable installing tool.

Note. Deflector must be 1–15/16 inch from end of shaft before installing in pump body.

(3) Press bearing and shaft assembly into bore in pump body. Use an arbor press and an installer tool which applies force to outside race of bearing.

(4) Position pump body on press with pulley hub end firmly supported on press base plate.

(5) Press impeller (9, fig. 3–29) on shaft as shown in figure 3–31. Use a collar between impeller and press ram. Press impeller on shaft to attain a maximum clearance of 0.0150 inch between impeller and body.

(6) Press pulley hub (1, fig. 3–29) on shaft in the same manner. Press pulley hub on shaft to leave a distance of 3.0900 to 4.0100 inches from bottom face of pump body to fan side of pulley hub flange.

(7) Rotate pulley hub and check for free rotation and proper operation of water pump. A slight drag between mating surfaces of seal assembly and impeller is normal.

e. Installation. Refer to TM 5–3805–239–12 and install the water pump on the engine.

Section V. LUBRICATION SYSTEM

3–16. General

a. The oil for the engine lubricating system is stored in the oil pan at the bottom of the engine. It is drawn from the pan by a gear-driven oil pump.

b. The oil pump is gear driven from a gear mounted on the rear end of the crankshaft. Oil under pressure is pumped through the oil cooler and the two oil filters to oil galleries in the cylinder block. The galleries carry the oil to all parts of the engine. Oil is also sent to the air compressor for lubrication.

3–17. Oil Pan

a. Removal.

(1) Refer to TM 5–3805–239–12 and drain oil from engine.

(2) Refer to paragraph 2–30 and remove the engine from the loader.

(3) Refer to figure 3–32 and remove the oil pan. Discard gaskets.

b. Cleaning. Clean oil pan with cleaning compound, solvent (Spec. P–S–661) and dry thoroughly. Clean all old gasket material from gasket surfaces on oil pan and engine.

c. Inspection and Repair.

(1) Inspect oil pan for cracks or other damage.

(2) Inspect oil drain plug boss for evidence of leakage.

(3) Repair, if possible, or replace all damaged oil pans.

d. Installation.

(1) Place a quantity of Permatex in corners formed by flywheel housing and block rails and where front support plate contacts block rails.

(2) Screw two guide studs into diagonal corners of cylinder block. Loosen screws securing front support plate to cylinder block.

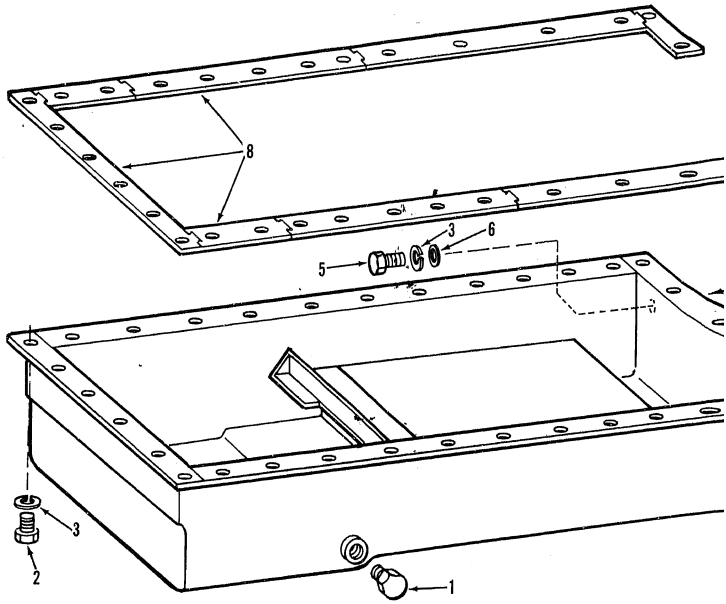
(3) Position oil pan, with front end up, on guide studs. Install two screws (2, fig. 3–32) and lockwashers (3) in corners to support oil pan. Do not tighten screws. Remove guide studs.

(4) Install screws in rear flange of oil pan. Tighten two rear corner screws and two upper screws in flywheel housing alternately until secure.

(5) Install remaining screws and washers and tighten all screws to a torque of 28 to 33 foot-pounds.

(6) Refer to paragraph 2–30 and install the engine in the loader.

(7) Refer to TM 5–3805–239–12 and fill the engine with oil.



1 Drain plug
2 Screw, cap, hex-head, 3/8-16 x 3/4 in. (25 rqr)
3 Washer, lock, 3/8 in. (37 rqr)
4 Screw, cap, hex-head, 3/8-16 x 7/8 in. (5 rqr)
5 Screw, cap, hex-head, 3/8-16 x 1 in. (7 rqr)
6 Washer, flat, 3/8 in.
7 Oil pan
8 Gasket set (9 pieces)

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Figure 3–32. Oil pan, removal and installation.

3–18. Oil Pump

a. Removal.

(1) Refer to TM 5–3805–239–12 and drain oil from the engine.

(2) Refer to paragraph 2–30 and remove the engine from the loader.

(3) Refer to paragraph 3–1 the oil pan.

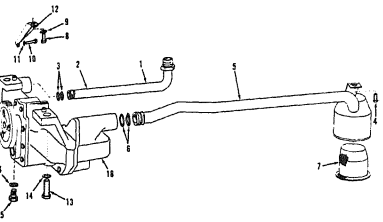
(4) Refer to figure 3–33 ar oil pump as follows.

(*a*) Remove screw (4), s lock washer (9). Remove screws and lock washers (14).

(c) Remove screen (7) from inlet tube 5). Remove inlet tube (5) from oil pump 16). Remove and discard packings (6).

(d) Remove outlet tube (2) from oil ump (16). Remove and discard packings (3).

(e) Remove screw (10) and lock washer 11) and remove bracket (12) from oil pump 16).



1. Tube nut
2. Oil outlet tube
3. Preformed packing (2 rqr)
4. Screw, cap, hex-head
5. Oil inlet tube
6. Preformed packing (2 rqr)
7. Inlet screen
8. Screw, cap, hex-head
9. Washer, lock
10. Screw, cap, hex-head, 5/16-18 x 2-1/2 in.
11. Washer, lock, 5/16 in.
12. Bracket
13. Screw, cap, hex-head, 1/2-13 x 1-1/2 in.
14. Washer, lock, 1/2 in. (2 rqr)
15. Screw, cap, hex-head, 1/2-13 x 3-1/2 in.
16. Oil pump assembly

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Figure 3–33. Oil pump, removal and installation.

b. Disassembly.

(1) Pull drive geat (1, fig. 3–34) from haft of pump.

(2) Remove screws (8 and 10) and lock (4), spring (5), piston (6), and valve body (7) from pump body (15).

(4) Remove screws (17) and lock washers (18) and remove rear cover (20) from pump body (15).

(5) Press drive gearshift (13) and driven gear (14) from body. Inspect bearings (12) and remove from cover, body, and gear if replacement is necessary.

(6) Remove pressure gear (2) and idler gear (21) from pump.

(7) Inspect dowel pins (16) and replace if necessary.

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

g. Inspection and Repair.

(1) Inspect gear teeth for wear and scoring. Replace worn or damaged gears.

(2) Inspect body and covers for scratches, scoring, and damage. Replace damaged parts.

(3) Radial clearance between pump gears and pump body should be 0.00075 to 0.00175 inch. When clearance exceeds 0.0060 inch replace worn parts.

(4) Backlash between idler gear and pressure gear should not exceed 0.0050 to 0.0060 inch. Replace gears if backlash exceeds tolerances.

(5) End clearance of gears in pump body should be 0.0020 to 0.0045 inch. When end clearance exceeds 0.0070 inch, replace worn parts.

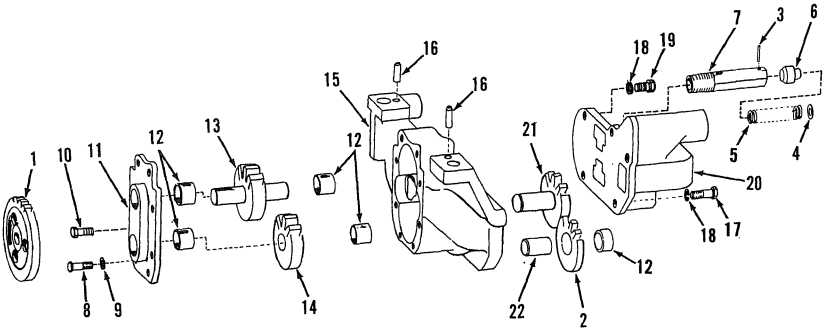
(*a*) Measure thickness of gears with a micrometer and record figures.

(*b*) Measure depth of gear counterbore in body with a depth micrometer.

(*c*) Subtract gear thickness from depth to obtain end clearance of gears.

(6) Inspect gearshafts and bushings for wear and scoring. Replace parts if worn or badly scored. Gearshafts should be 0.8715 to 0.8720 inch in diameter. Replace gearshafts as a unit.

(7) Inspect relief valve piston for wear and scoring. Piston must slide smoothly in valve body. Clearance between piston and body should be 0.0040 to 0.0060 inch. Replace worn or scored parts.



1 Pump drive gear
2 Pressure gear
3 Pin, spring
4 Washer, flat
5 Spring
6 Relief valve piston
7 Valve body
8 Screw, cap, hex-head, 5/16–18 x 1 in. (6)
9 Washer, lock, 5/16 in. (6)
10 Screw, self-locking, 5/16–18 x 9/16 in. (2)
11 Front cover
12 Sleeve bearing (5)
13 Drive gearshaft
14 Driven gear
15 Body
16 Pin, dowel (2)
17 Screw, cap, hex-head, 5/16–18 x 1 in. (3)
18 Washer, lock, 5/16 in. (4)
19 Screw, cap, hex-head, 5/16–18 x 2 in.
20 Rear cover
21 Idler gear
22 Idler gearshaft

Figure 3–34. Oil pump assembly, exploded view.

(8) Inspect screens and tubes for damage. Replace damaged parts.

e. Reassembly.

(1) If bearings (12, fig. 3–34) were removed, press bearings into cover and gear until end of bearing is flush to 0.0040 inch below surface of body or gear.

(2) Install idler gear (21) and pressure gear (2) in body (15). Press driven gear (14) on shaft of pressure gear and press driven gearshaft (13) through idler gear.

(3) Install rear cover (20) on body (15) and secure with screws (17) and lock washers (18). Install front cover (11) and secure with screws (8 and 9) and lock washers (10). Tighten all screws to a torque of 9 to 11 foot pounds.

(4) Install valve body (7), piston (6), spring (5) and washer (4). Secure valve with pin (3).

(5) Press drive gear (1) on pump shaft.

f. Installation.

(1) Install bracket (12, fig. 3–33) an oil pump (16) and secure with screw (10) and lock washer (11).

(2) Install outlet tube (2) on oil pump (16) using new packings.
3). Install inlet tube (5) on oil pump using new packings.
(6). Install screen (7) in inlet tube.

(3) Install oil pump, with attached tubes, on bottom of cylinder block. Aline dowel pins on pump with holes in the block. Connect tube nut (1) to threaded opening in cylinder block. Secure bracket (12) to block with screw (8) and lock washer (10).

(4) Secure oil pump to block with screws (13 and 15) and lock washers (14). Tighten screws to a torque of 44 to 49 foot pounds.

(5) Check backlash between oil pump drive gear (1, fig. 3–34) and crankshaft gear. Backlash should be 0.0030 to 0.0070 inch and should not exceed 0.0200 inch.

(6) Refer to paragraph 3–17 and install the oil pan on the engine.

(7) Refer to paragraph 2–30 and install the engine in the loader.

(8) Refer to TM 5–3805–239–12 and fill the engine with oil.

3–19. Oil Pressure Regulating Valve

a. Removal. Refer to TM 5–3805–239–12 and remove the oil pressure regulating valve.

b. Cleaning. Clean all parts in cleaning compound solvent (Spec P–S–661) and dry thoroughly with compressed air.

c. Inspection and Repair.

(1) Inspect spring for cracks, damage, and signs of fatigue. Replace spring if damaged.

(2) Inspect piston for wear and scoring. Piston must move freely in valve bore. Replace worn or scored piston.

(3) Inspect threads on adjusting screw for damage. Replace screw if damaged.

d. Installation. Refer to TM 5–3805–239–12 and install oil pressure regulating valve. Adjust oil pressure (TM 5–3805–239–12) to 40 to 55 psi at high idle.

Section VI. CYLINDER HEAD AND ASSOCIATED PARTS

3–20. General

a. The cylinder head is a one-piece iron alloy casting. The head is secured to the block with heat treated screws. Ports in the head provide for the intake of air and removal of exhaust gases.

b. The intake and exhaust valves operate in guides within the cylinder head. Hardened exhaust valve seats are pressed into the head and ground to very close tolerances to match the valves.

c. Rocker arms, mounted on a common shaft, actuate the valves. Push rods extend through the head to the valve lifters. The push rods operate the rocker arms as the camshaft moves the lifters.

3–21. Rocker Arms

a. Removal.

(1) Refer to TM 5–3805–239–12 and remove the breather tube, air cleaner, turbocharger, and air intake tubes.

(2) Remove screws (1, fig. 3–35) and lock washers (2) and remove cover (3) and gasket (4) from cylinder head.

(3) Remove six screws (1, fig. 3–36) and lock washers (2) and six screws (3) securing rocker arm brackets (4) to the cylinder head.

(4) Disconnect nuts and remove oil inlet tube (5) and oil drain tube (6).

(5) Remove elbows (8 and 9) and remove plug (10) and washers (11 and 12) from each end of shaft.

(6) Remove shaft and rocker arms from cylinder head as an assembly.

(7) Remove screw (13) and lock washer (2) from third bracket from front. Remove rocker arms (14), brackets (4) and springs (15) from shaft.

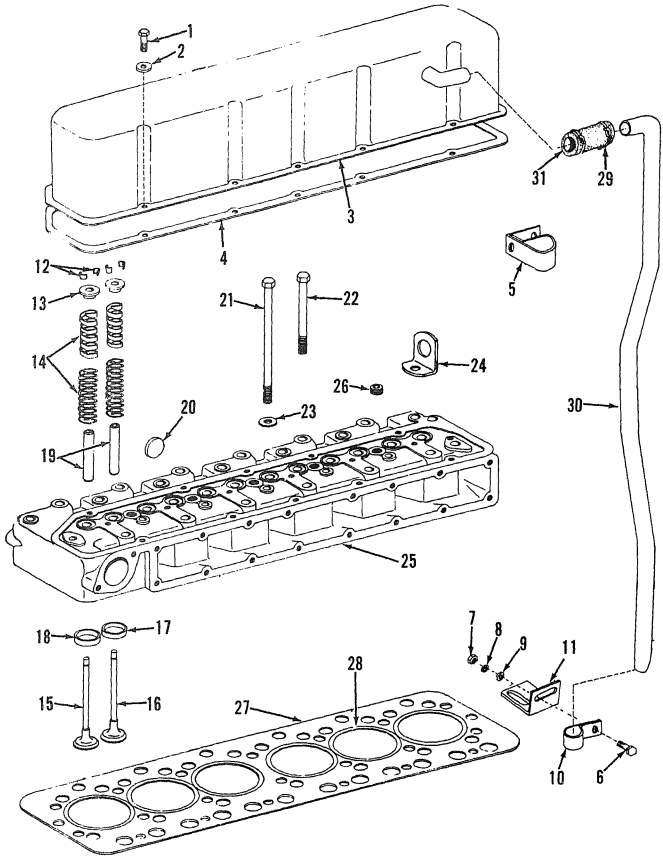
(8) Remove adjusting screws (16) from rocker arms. Remove push rods (18) from head.

(9) Remove push rods (18) from cylinder head.

b. Cleaning. Clean parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

c. Inspection and Repair.

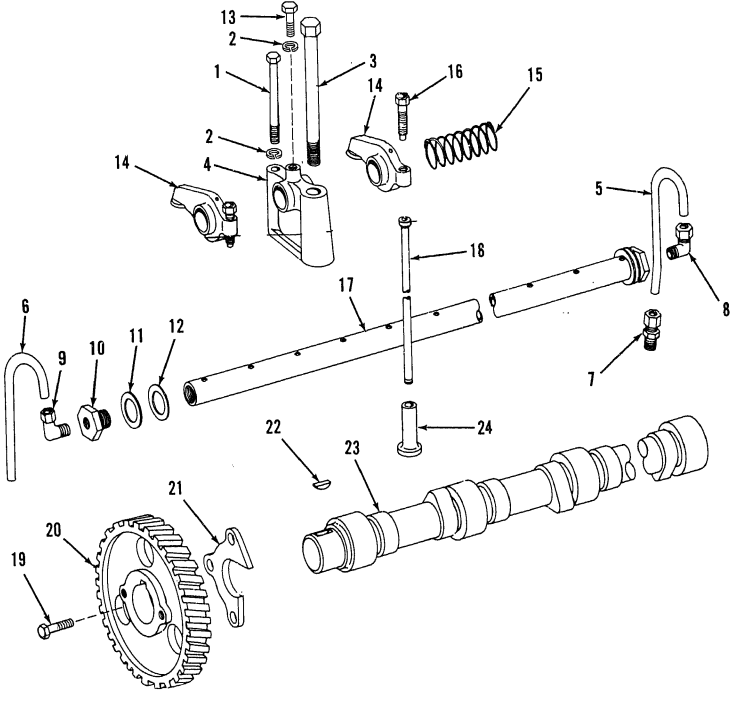
(1) Inspect ends of rocker arms and rocker arm adjusting screws for wear and damage. Replace worn or damaged parts.



1 Screw, cap, hex-head (10 rqr)
2 Washer (10 rqr)
3 Cylinder head cover
4 Gasket
5 Clamp
6 Screw, cap, hex-head, 3/8-16 x 3/4 in.
7 Nut, 3/8-16
8 Washer, lock, 3/8 in.
9 Washer, flat, 3/8 in.
10 Clamp
11 Bracket
12 Lock, retainer (24 rqr)
13 Retainer, spring (12 rqr)
14 Spring assembly (12 rqr)
15 Exhaust valve (6 rqr)
16 Intake valve (6 rqr)
17 Intake valve seat (6 rqr for repair only)
18 Exhaust valve seat insert (6 rqr)
19 Valve guide (6 rqr)
20 Expansion plug (5 rqr)
21 Screw, cap, hex-head (6 rqr)
22 Screw, cap, hex-head (20 rqr)
23 Washer (26 rqr)
24 Lifting eye (2 rqr)
25 Cylinder head
26 Pipe plug (5 rqr)
27 Cylinder head gasket
28 Fire ring gasket (6 rqr)
29 Hose clamp (2 rqr)
30 Breather tube
31 Hose

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Figure 3-35. Cylinder head and assorted parts, exploded view.



1 Screw, cap, hex-head, 3/8-16 x 3-3/4 in. (6 rqr)
2 Washer, lock, 3/8 in. (7 rqr)
3 Screw, cap, hex-head (6 rqr) (same as 21, fig. 3-35)
4 Rocker arm bracket (6 rqr)
5 Oil inlet tube
6 Oil drain tube
7 Adapter
8 Elbow
9 Elbow
10 Plug (2 rqr)
11 Washer, spacing (2 rqr)
12 Washer, spacing (2 rqr)
13 Screw, cap, hex-head, 3/8-16 x 1 in.
14 Rocker arm (12 rqr)
15 Spring (5 rqr)
16 Adjusting Screw (12 rqr)
17 Rocker arm shaft
18 Push rod (12 rqr)
19 Bolt (3 rqr)
20 Camshaft gear
21 Thrust plate
22 Woodruff key
23 Camshaft
24 Valve lifter (12 rqr)

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Figure 3-36. Rocker arms and camshaft, exploded view.

(2) Inspect rocker arm sleeve bearings for wear. Inside diameter of sleeve bearings should be from 1.0010 to 1.0020 inch. Outside diameter of rocker arm shaft should be from 0.9990 to 1.0000 inch. Clearance between shaft and bearings should be 0.0010 to 0.0030 inch and must not exceed 0.0050 inch. If bearings or shaft are worn beyond these limits replace rocker arm assemblies.

(3) Inspect rocker arm shaft for wear and damage and to dimensions shown above. Replace shaft if worn or damaged. Clean oil holes in shaft and rocker arms with a soft wire and blow clean with compressed air.

(4) Check springs for damage and loss of tension. Replace damaged or weak springs.

(5) Inspect all threaded parts for damaged threads. Repair or replace parts with damaged threads.

(6) Inspect push rods for damage and wear to ends. Remove nicks and scores with crocus cloth. If rods are bent, twisted or damaged, replace rods.

d. Installation. Refer to figure 3–36 and the following instructions to install the rocker arms.

(1) Aline hole in rocker arm shaft (17) with threaded hole in rocker arm bracket (4) (third bracket from front of engine). Install screw (13) and lock washer (2) to secure shaft to bracket.

(2) Lubricate rocker arms (14) and shaft with engine oil (OE) and install rocker arms, springs (15), and brackets (4) on rocker arm shaft.

(3) Install spacing washers (11 and 12) and plugs (10) on each end of shaft. Tighten plugs to a troque of 40 foot-pounds.

(4) Install elbows (8 and 9) and oil tubes (5 and 6) on ends of shaft.

(5) Install push rods (18) in cylinder head. Be certain rods are seated properly in valve lifters.

(6) Position assembled rocker arms on cylinder head. Connect oil tubes to adapters. Aline adjusting screws (16) with cupped ends of push rods. Lubricate threads with engine oil (OE) and install screws (1 and 3) and lock washers (2). Tighten screws (3) to a torque of 130 to 140 foot-pounds, starting at center of head and working alternately towards each end. Tighten screws (1) to a torque of 28 to 33 foot-pounds.

(7) Refer to paragraph 3–22 and adjust valve clearances (both hot and cold engine).

(8) Install cylinder head cover (3, fig. 3–35) and new gasket (4) on engine.

(9) Secure cover with screws (1) and washers (2) and tighten screws.

(10) Refer to TM 5–3805–239–12 and install crankcase breather tube, air tubes, air cleaner, and turbocharger.

3–22. Valve Clearance Adjustment

a. General. Whenever the valve clearances have been disturbed due to repair work or it becomes noticeable that the valves are not working properly, the valves should be inspected and the clearance adjusted. This should be performed periodically to maintain good engine operation.

b. Value Adjustment (cold engine). Refer to paragraph 3–21 and remove cylinder head cover.

(1) Adjust clearance (cold engine) between valve stems and rocker arms to 0.0180 inch as illustrated in figure 3–37 and described below.

(2) Turn rocker arm adjusting screws up to prevent rocker arms and push rods from opening too far. Rotate engine to bring piston in cylinder to be adjusted to near top dead center. When exhaust valve of No. 6 cylinder is almost closed and intake valve starts to open, piston of No. 6 cylinder is near top dead center on its exhaust stroke. No. 1 piston is in the same position on its compression stroke.

(3) Insert a feeler gage (fig. 3–37) between rocker arm and valve stem and turn adjusting screw (fig. 3–37) to provide 0.0180 inch clearance between No. 1 intake and exhaust valves and rocker arm.

(4) Rotate engine until No. 2 cylinder exhaust valve is almost closed and intake valve starts to open. Adjust clearance on No. 5 cylinder intake and exhaust valves to 0.0180 inch as described above.

(5) Rotate engine until No. 4 cylinder exhaust valve is almost closed and intake valve starts to open. Adjust clearance on No. 3 cylinder intake and exhaust valves to 0.0180 inch as described above.

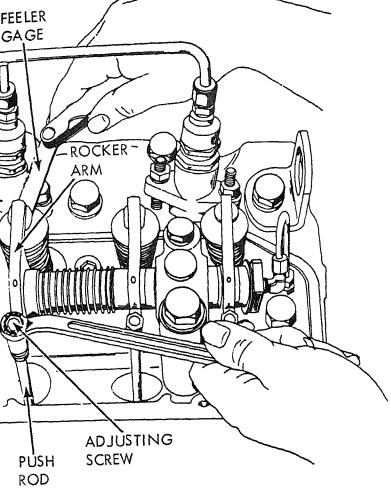


Figure 3–37. Adjusting valve clearance.

(6) Rotate engine until No. 1 cylinder exaust valve is almost closed and intake valve tarts to open. Adjust clearance on No. 6 cylinder intake and exhaust valves to 0.0180 inch as escribed above.

(7) Rotate engine until No. 5 cylinder exaust valve is almost closed and intake valve tarts to open. Adjust clearance on No. 2 cylinder intake and exhaust valves to 0.0180 inch as escribed above.

(8) Rotate engine until No. 3 cylinder exaust valve is almost closed and intake valve tarts to open. Adjust clearance on No. 4 cylinder intake and exhaust valves to 0.0180 inch as escribed above.

(9) Refer to paragraph 3–21 and install ylinder head cover.

c. Valve Clearance (hot engine).

(1) Start engine and run until a minimum emperature of 180° F is reached. Stop engine.

(2) Refer to paragraph 3–21 and remove ylinder head cover.

(4) When setting clearance, feeler gage should pass between rocker arm and valve stem with a slight drag when clearance is properly adjusted.

(5) Refer to paragraph 3–21 and install cylinder head cover.

3–23. Cylinder Head

a. Removal.

(1) Refer to TM 5–3805–239–12 and drain the engine cooling system.

(2) Refer to TM 5–3805–239–12 and remove the following:

(*a*) Engine hood.
(*b*) Air cleaner.
(*c*) Turbocharger and exhaust system.
(*d*) Thermostat housings.
(*e*) Air compressor air inlet tube.
(*f*) Intake manifold.
(*g*) Exhaust manifold.
(*h*) Fuel injection lines and nozzles.

(3) Refer to paragraph 3–21 and remove cylinder head cover, rocker arms, and push rods.

(4) Remove 20 screws (22, fig. 3–35) securing cylinder head (25) and lifting eyes (24).

(5) Attach a suitable sling to the cylinder head and, using a hoist, lift the cylinder head straight up until it clears the two dowel pins in the engine block. Remove cylinder head carefully to avoid damage to head or engine.

(6) Remove cylinder head gasket (27) and fire ring gaskets (28).

b. Disassembly.

(1) Compress valve springs (14, fig. 3–35) with a suitable spring compressor and remove twelve retainers locks (12).

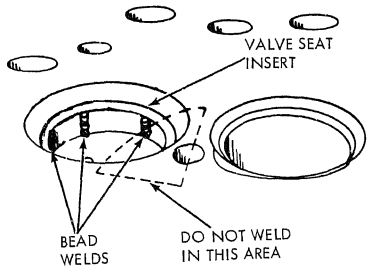
(2) Carefully release tension on springs and remove spring retainers (13) and springs from cylinder head.

(3) Tag valves (15 and 16) with cylinder numbers and remove valves from head.

(4) If inspection shows valve guides (19) require replacement, remove valve guides from cylinder head by using a suitable tool to press guides from head.

(5) Inspect valve seats and inserts (17 and 18) for wear cracks, pitting, and to see if

they are loose. If exhaust valve seat inserts require replacement, weld three small beads as shown on figure 3–38 on the insert. Allow insert to cool and lift or pry inserts from head.



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Figure 3–38. Beads welded for removal of exhaust valve seat insert.

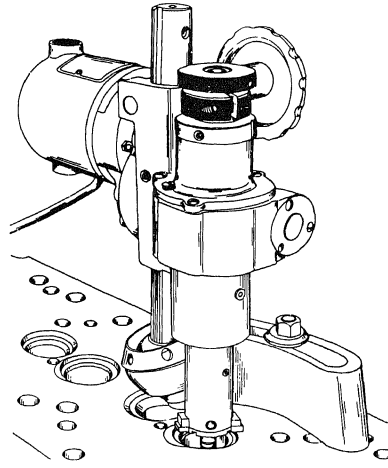
c. Cleaning. Clean cylinder head with cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air. Soak carbon deposits with carbon removing compound (MIL–C–5546A, FSN 6810–141–6526). Rinse with kerosene or hot water and remove softened carbon with a rag or soft brush.

d. Inspection and Repair.

(1) Inspect cylinder head for wear and damage. Replace cylinder head if worn or damaged beyond repair.

(2) Inspect intake valve seats for wear, damage, cracks, and pitting. If intake valve seats require repair or removal the cylinder head must be machined to receive the insert.

(*a*) Rebore the cylinder head with a tool similar to the one illustrated on figure 3–39 to the dimensions shown in table 3–2.



MEC 3805-239-12/3-39

Figure 3-39 Reboring cylinder head.

Table 3–1. Cylinder Head Machining Dimensions

Insert	O.D. of new insert	Diameter of bore in cylinder head	Depth of bore
Standard size exhaust	1.6670 to 1.6680	1.6650 to 1.6660	0.4735 to 0.4355
0.0050 oversize exhaust	1.6720 to 1.6730	1.6700 to 1.6710	0.4735 to 0.4355
Intake (for service only)	1.8160 to 1.8170	1.8140 to 1.8150	0.4585 to 0.4605

(*b*) The dimensions shown in the table provide an interference fit of 0.0010 to 0.0030 inches for both types of inserts.

(*c*) The depth of the counterbores is measured from the bottom deck of the cylinder head.

(*f*) Use a suitable installing tool to drive the valve seats into the cylinder head.

(*g*) After installation stake the exhaust valve seat insert in three places. Do not stake insert in the area close to the injection nozzle.

(3) Regrind valve seat inserts as follows.

(*a*) Grind seats with suitable grinding wheels set for 15°, 30°, 45°, and 60°.

(*b*) Grind the intake valve seat insert to an angle of 45°. Grind the exhaust valve seat to an angle of 30°.

(*c*) After seat has been ground, check the valve against the valve seat. Wipe a thin film of Prussian blue on the valve face and bounce valve once on the valve seat. Check the contact areas. A thin continuous line must show around the valve face. If not, regrind valve.

(*d*) Figure 3–40 shows correct and incorrect valve seat angles.

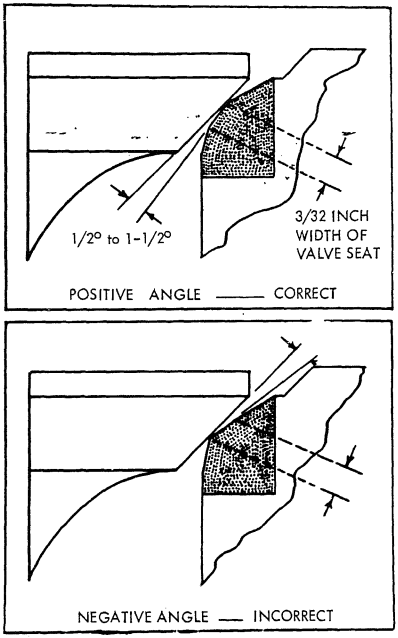
(*e*) After grinding seat use a dial gage to check concentricity of valve seat in relation to valve guide.

(*f*) Install new valve guides (19, fig. 3–35) (if necessary) in cylinder head by pressing the guides into the head with an arbor press and a suitable adapter. Exhaust valve guide must protrude 1 3/32 inch from the bottom of the counterbore at the top of the cylinder head. Intake valve guide must protrude 25/32 inch from the bottom of the counterbore.

(*g*) Total run out of seat from the valve guide should not exceed 0.0020 inch total indicator reading.

(*h*) Install valves (15 and 16) in cylinder head. Heads of exhaust valves must be set in a minimum of 0.0530 inch from the gasket surface of the head. Intake valves must be set in a minimum of 0.0540 inch from the gasket surface. If this is not met, the inserts must be ground further to allow the valves to seat properly.

(4) Inspect valves (15 and 16, fig. 3–35) for cracked, bent, or burned faces and worn stems. Check valves and stems against tolerances specified in the repair and replacement standards. Replace valves if they are damaged or do not meet these standards.



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Figure 3–40. Valve seat angles.

(5) Inspect valve springs for cracks and other damage. Check springs for tension. Both valve springs with dampers should have a load of 40 to 46 pounds at a length of 2.2370 inches and a load of 105 to 115 pounds at a length of 1.7800 inches. Replace damaged springs or springs which do not meet these tolerances.

e. Reassembly.

(1) Install valve guides (18, fig. 3–35) using a suitable pressing tool as described in *d*

above, if they have not previously been installed.

(2) Using a suitable spring compressor, install valve springs (14), spring retainers (13), and locks (12) on valve stems.

(3) Clean cylinder block and cylinder head thoroughly. Clean screw holes in cylinder head to remove any oil that may be present.

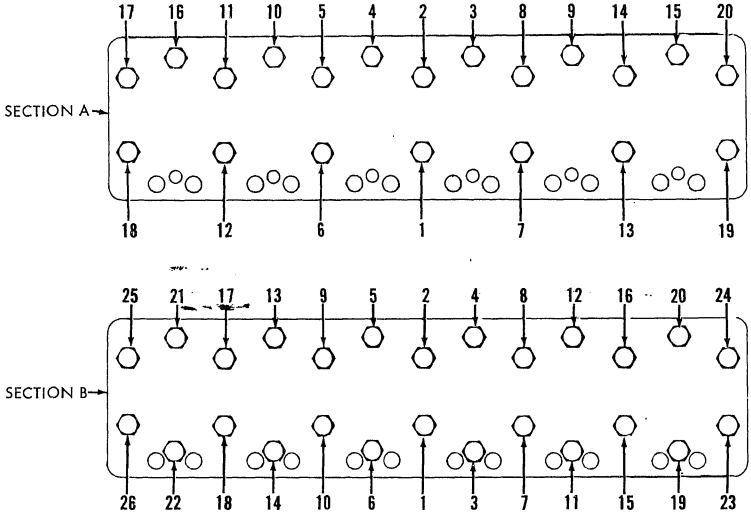
(4) Check cylinder block. Cylinder sleeves must not extend more than 0.0020 to 0.0050 inch above the cylinder block.

(5) Install new fire ring gaskets (28) and new head gasket (27).

(6) Lift cylinder head with a suitable sling and hoist and lower cylinder head on block with head alined with dowel pins.

(7) Lubricate threads of screws (22) with engine oil (OE) and install screws. Tighten screws to a torque of 90 to 110 foot-pounds in the sequence shown in section A of figure 3–41.

(8) Refer to paragraph 3–21 and install the push rods and rocker arms.



MEC 3805-239-35/3-41

Figure 3–41. Cylinder head screw torquing sequence.

(9) Tighten the cylinder head screws to a torque of 130 to 140 foot-pounds. Include the six long rocker arm screws in the sequence as shown in section B of figure 3–41.

Note Use an offset wrench to torque screws under the rocker arm shaft.

(10) Tighten the cylinder head screws (26 of them) in the sequence shown in section B of figure 3–41 to a final torque of 130 to 140 foot-pounds.

(11) Refer to paragraph 3–22 and adjust valve clearances for a cold engine.

(12) Refer to paragraph 3–21 and install the cylinder head cover.

(13) Refer to TM 5–3805–239–12 and install the following:

(*a*) Fuel injection lines and nozzles.
(*b*) Exhaust manifold.
(*c*) Intake manifold.
(*d*) Air compressor air inlet tube.
(*e*) Thermostat housings.
(*f*) Turbocharger and exhaust system.
(*g*) Air cleaner.
(*h*) Engine hood.

(14) Refer to TM 5–3805–239–12 and fill he engine cooling system.

(15) Start the engine and allow to run ntil temperature reaches a minimum of 180 F. Stop engine.

(16) Refer to paragraph 3–21 and remove the cylinder head cover.

(17) Tighten all 26 cylinder head screws in the sequence shown in section B of figure 3–41 to a torque of 130 to 140 foot-pounds.

(18) If screw does not move when this torque is reached, back screw off slightly and retighten to the specified torque.

(19) Adjust valve clearance to 0.0150 inch as described in paragraph 3–22 (hot engine).

(20) Refer to paragraph 3–21 and install cylinder head cover.

(21) Check engine for fuel, water, and oil leaks. Correct leaks if any are found.

Section VII. FRONT END AND GEAR TRAIN

3–24. General

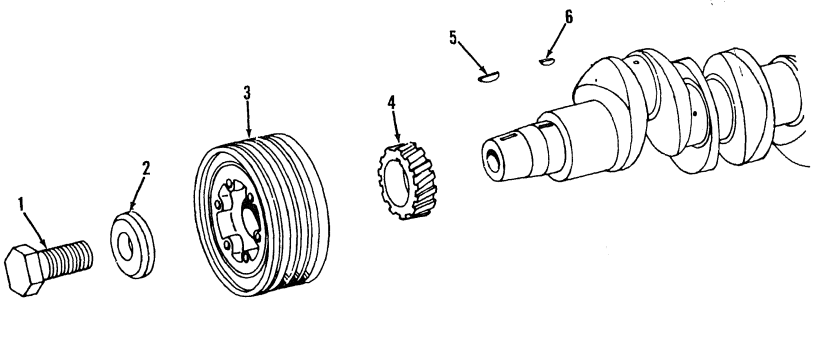
a. The crankshaft pulley and damper are attached directly to the front end of the crankshaft. The pulley has a rubber torsional damper bonded between the hub section and the pulley section to aid in reducing crankshaft vibration.

b. The gear train is enclosed by the timing gear cover. An access cover is provided to inspect the fuel injection pump drive gear. The gear train consists of the crankshaft gear which drives the idler gear and the camshaft gear. The idler gear in turn drives the fuel injection pump drive gear.

3–25. Crankshaft Pulley and Damper

a. Removal.

(1) Refer to TM 5–3805–239–12 and drain the cooling system and remove the radiator and water pump, generator, and compressor drive belts.



1 Pulley screw
2 Pulley washer
3 Pulley and damper
4 Crankshaft gear
5 Woodruff key
6 Woodruff key

MEC 3805-239-35/3-42

Figure 3–42. Crankshaft pulley and damper and crankshaft gear, exploded view.

(2) Loosen pulley screw (1, fig. 3–42) and turn it out approximately ½ inch.

(3) Install a suitable puller and pull pulley (3) loose from crankshaft.

(4) Remove screw (1) and washer (2) from pulley and damper.

(5) Remove pulley and damper and key (5) from crankshaft.

b. Cleaning. Clean pulley and damper thoroughly with soap and water. Use a rag dipped in cleaning compound, solvent (Spec. P–S–661) to clean grease and oil from pulley metal parts. Do not get solvent on rubber portion of damper.

c. Inspection and Repair. Inspect pulley and damper for nicks and damage to pulley grooves. Remove nicks and rough spots with a fine file. Inspect rubber portion for cracks and damage. Replace pulley and damper if it cannot be repaired.

d. Installation.

(1) Install woodruff key (5, fig. 3–42) in keyway in crankshaft.

(2) Position pulley and damper (3) on crankshaft and key. Install washer (2) and secure with screw (1).

(3) Tighten screw to a torque of 220 foot-pounds.

(4) Refer to TM 5–3805–239–12 and install water pump, generator, and air compressor belts and radiator.

(5) Refer to TM 5–3805–239–12 and fill the engine cooling system.

3–26. Timing Gear Cover

a. Removal.

(1) Refer to paragraph 3–25 and remove the crankshaft pulley and damper.

(2) Refer to paragraph 3–17 and remove the oil pan.

(3) Remove screws (1, fig. 3–43) and remove inspection plate (2) and gasket (3). Discard gasket. Remove spring (1, fig. 3–15) and thrust button (2) from injection pump drive shaft.

(4) Remove screws (4, fig. 3–43) and lock washers (5) and remove cover plate (6) and gasket (7). Discard gasket.

(5) Remove screws (10, 11, 12, and 13), lock washers (8), and flat washers (9).

(6) Tap timing gear cover (14) with a leather hammer to jar it loose. Pry cover from locating dowels and remove it from engine.

(7) Remove and discard gasket (15).

(8) Using a suitable driving tool, drive crankshaft front oil seal (28) from timing gear cover.

b. Cleaning. Clean cover and all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

c. Inspection and Repair.

(1) Inspect timing gear cover for cracks and elongated holes. Inspect oil seal bore for scratches, scores, and damage.

(2) Repair timing gear cover by welding cracks, if possible. Replace a damaged timing gear cover.

d. Installation.

(1) Install a new oil seal (28, fig. 3–43) in the bore of timing gear cover. The outside diameter of the seal has a red sealant and the inside diameter has a rubber compound to prevent leaks.

(2) Place the timing gear cover (14) on a flat surface.

(3) Position oil seal in bore with open side of seal facing down (toward engine) and with seal positioned squarely in the bore of cover.

(4) Drive or press oil seal, using a suitable tool, into bore until it bottoms. Driving force must be on the outer edge of the seal. Do not press on open face of seal.

(5) Insert fingers into inner part of seal. If seal is installed properly, inner part can be turned with fingers.

(6) Install spring (1, fig. 3–15) and thrust button (2) on fuel pump shaft.

(7) Coat crankshaft lightly with engine oil (OE). Cement a new gasket (15, fig. 3–43) on timing gear cover (14).

(8) Position timing gear cover on dowel pins and secure with screws (10, 11, 12, and 13). Tighten screws to a torque of 28 to 33 foot-pounds.

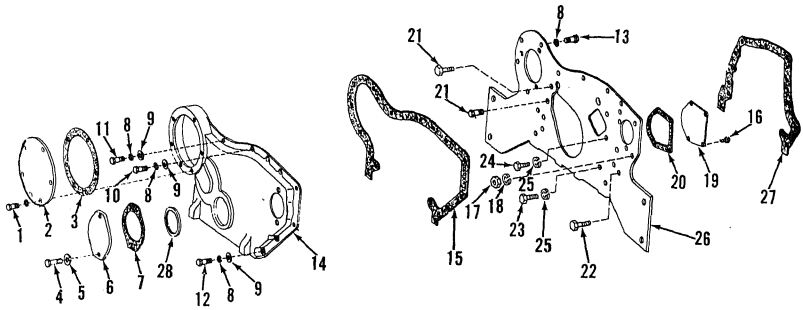
(9) Install covers (2 and 6) in reverse of the removal procedure.

(10) Refer to paragraph 3–17 and install the oil pan.

(11) Refer to paragraph 3–25 and install the crankshaft damper and pulley.

3–27. Gear Train

a. Removal.



1 Screw, cap, hex-head, 3/8-16 x 1 in. (6 rqr)
2 Inspection plate
3 Gasket
4 Screw, cap, hex-head, 3/8-16 x 1 in. (2 rqr)
5 Washer, lock, 3/8 in. (2 rqr)
6 Cover plate
7 Gasket
8 Washer, lock, 3/8 in. (7 rqr)
9 Washer, flat, 3/8 in. (5 rqr)
10 Screw, cap, hex-head, 3/8-16 x 1 in. (2 rqr)
11 Screw, cap, hex-head, 3/8-16 x 1-1/2 in.
12 Screw, cap, hex-head, 3/8-16 x 3-1/2 in. (2 rqr)
13 Screw, cap, hex-head, 3/8-16 x 2-1/2 in. (2 rqr)
14 Timing gear cover
15 Gasket
16 Screw, cap, hex-head, 3/8-16 x 1-7/8 in. (2 rqr)
17 Nut, 3/8-16 (4 rqr)
18 Washer, lock, 3/8 in. (4 rqr)
19 Cover plate
20 Gasket
21 Lock bolt (2 rqr)
22 Lock bolt
23 Screw, cap, hex-head, 3/8-16 x 1 in. (3 rqr)
24 Screw, cap, hex-head, 3/8-16 x 1-1/8 in. (3 rqr)
25 Washer, lock, 3/8 in. (6 rqr)
26 Front support plate
27 Gasket
28 Oil Seal

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Figure 3–43. Timing gear cover and front support plate, exploded view.

(1) Refer to paragraph 3–26 and remove the timing gear cover.

(2) Figure 3–44 illustrates the gear train at the front of the engine.

(3) Check alinement of timing marks on gears as illustrated on figure 3–44.

(4) Check backlash between gears in the gear train. Backlash should not exceed 0.0200 inch between any two gears. If backlash exceeds this, replace worn gears.

(5) Rotate engine until No. 1 piston is at top dead center on its compression stroke and the timing marks on gears are alined as shown on figure 3–44.

(6) Refer to paragraph 3–33 and remove camshaft and camshaft gear.

(7) Use a suitable puller and pull crankshaft gear (4, fig. 3–42) from crankshaft. Remove key (6) from crankshaft.

(8) Remove nut (1, fig. 3–45) and lock washer (2) securing fuel pump drive gear to pump shaft.

(9) Use a suitable puller and pull fuel pump drive gear (3) from pump shaft. Remove

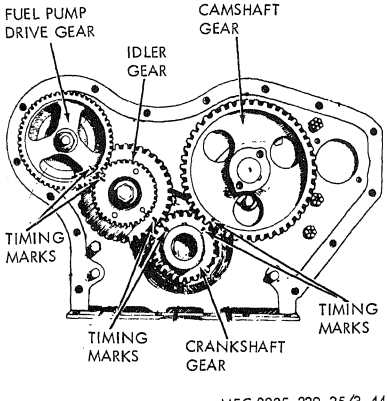


Figure 3–44. Gear train and timing marks.

key from shaft. Remove and discard packing (4).

(10) If adapter (5) is to be removed for replacement, refer to paragraph 3–7 and remove the fuel injection pump. Remove screws (12), nuts (13), and lock washers (14) and remove adapter from front support plate. Remove seal (7).

(11) Inspect sleeve bearing (6) for wear and check inside diameter. Inside diameter must be 0.8750 to 0.8770 inch. If bearing is worn, press bearing from adapter.

(12) Remove screw (1, fig. 3–46) and washer (2) and remove idler gear (4) from idler gear shaft.

(13) Check bearing (3) for wear and against tolerances listed in the repair and replacements standards. If bearing is worn or does not meet the standards, press or drive bearing from gear.

(14) Check idler gear shaft (5) for wear and against standards listed in repair and replacement standards. If shaft is worn or does not meet standards use a suitable slide hammer puller and remove the idler gear shaft from the engines block.

b. Cleaning. Clean all metal parts i ing compound, solvent (Spec. P–S–6 dry thoroughly with compressed air.

c. Inspection and Repair.

(1) Inspect gears for worn or teeth. Check gears against tolerances repair and replacement standards. worn or damaged gears and gears tha conform to repair and replacement stan

(2) Inspect fuel pump adapter a for wear and damage. Replace studs adapter if worn or damaged.

(3) Inspect all shafts and beari faces for wear or damage. Replace al viceable parts.

d. Installation.

(1) If bearing (3, fig. 3–46) was r from idler gear (4) install a new spa races by pressing into bore of gear.

(2) If idler gear shaft (5) was r from engine, install new shaft, with oil shaft lined up with slot in support pla lustrated on figure 3–47.

(3) Install screw (1, fig. 3–46) an ers (2) on shaft and tighten screw un gear shaft bottoms in cylinder block. screw and washer.

(4) If sleeve bearing (6, fig. 3–45) moved from adapter (5), press new into bore of adapter.

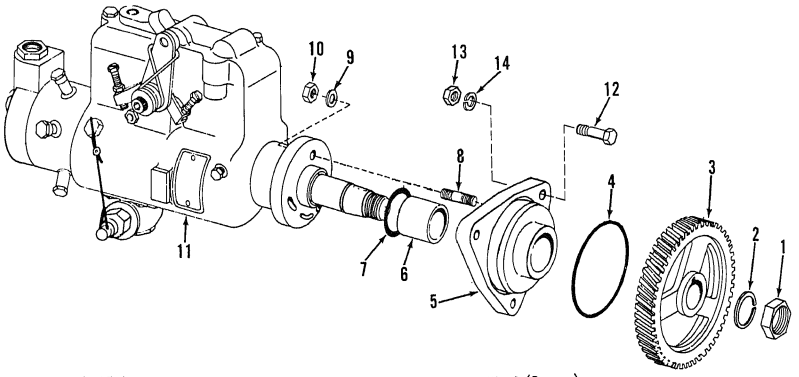
(5) Install adapter on front suppo and secure with screws (12), nuts (1 lock washers (14). Tighten nuts to a to 18 to 21 foot-pounds.

(6) Refer to paragraph 3–7 and ins fuel injection pump.

(7) Rotate engine to bring No. 1 p top dead center of the compression str stall key (6, fig. 3–42) in crankshaft.

(8) Heat crankshaft gear (4) in temperature of approximately 300° F crankshaft and key with a mixture o lead and engine oil (OE). Use asbestos to handle gear and drive or press g crankshaft.

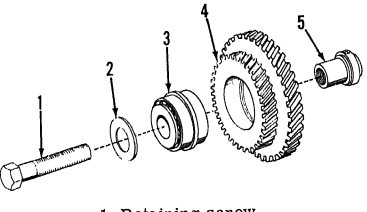
(9) Apply a light coat of engine oi to idler gear shaft. Aline timing mark c gear (fig. 3–44) with timing mark on shaft gear and install idler gear on idl shaft. Secure idler gear with washer 3–46) and screw (1). Tighten screw torque of 95 to 105 foot-pounds.



1 Nut
2 Washer, lock
3 Fuel pump drive gear
4 Packing, preformed
5 Pump adapter
6 Sleeve bearing
7 Oil seal
8 Stud (2 rqr)
9 Nut (2 rqr)
10 Washer, lock (2 rqr)
11 Fuel injection pump
12 Screw, cap, hex-head (3 rqr)
13 Nut (3 rqr)
14 Washer, lock (3 rqr)

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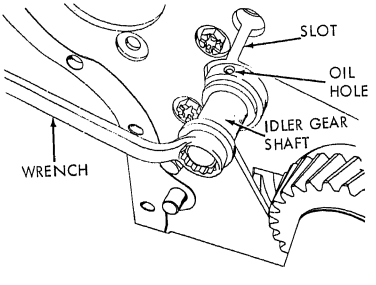
Figure 3-45. Fuel injection pump and drive gear, exploded view.



1 Retaining screw
2 Washer
3 Bearing
4 Idler gear
5 Idler gear shaft

MEC 3805-239-35/3-46

Figure 3-46. Idler gear, shaft, and bearing, exploded view.



MEC 3805-239-35/3-47

Figure 3-47. Installing idler gear shaft.

(10) Install key in fuel pump drive shaft. Install fuel pump drive gear (fig. 3–44) on shaft with timing mark on gear alined with timing mark on idler gear. Secure gear with lock washer (2, fig. 3–45) and nut (1). Tighten nut to a torque of 35 to 40 pound feet.

(11) Refer to paragraph 3–33 and install camshaft gear.

(12) Check backlash between gears. Backlash should not exceed 0.0200 inch. Replace gears as required to obtain correct backlash.

(13) Refer to paragraph 3–26 and install the timing gear cover.

3–28. Front Support Plate

a. Removal.

(1) Refer to paragraph 3–26 and remove the timing gear cover.

(2) Refer to paragraph 3–33 and remove the camshaft gear.

(3) Refer to paragraph 3–27 and remove fuel pump drive gear and adapter idler gear and shaft, and crankshaft gear.

(4) Place a jack under the engine to support engine and remove engine front mounting brackets (fig. 2–4) from front support plate and loader frame.

(5) Remove screws (23 and 24, fig. 3–43), lock bolts (21 and 22), and lock washers (25) and remove front support plate (26) from engine. Remove and discard gasket (27).

(6) Remove two screws (16) and four nuts (17) and lock washers (18) and remove cover plate (19) and gasket (20) from front support plate. Discard gasket.

b. Cleaning. Clean front support plate in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

c. Inspection and Repair. Inspect front support plate for cracks, elongated holes, and bent or dented surfaces. Replace damaged front support plates.

d. Installation.

(1) Install cover plate (19, fig. 3–43) and new gasket (20) on front support plate (26). Secure cover plate with two screws (16) and four nuts (17) and lock washers (18).

(2) Install front support plate and new gasket (27) on engine block and secure with screws (23) and (24), washers (25) and lock bolts (21 and 22).

(3) Install engine front mounting brackets (fig. 2–4) on front support plate and loader frame. Remove jack from beneath engine.

(4) Refer to paragraph 3–27 and install fuel pump drive gear and adapter, idler gear and shaft, and crankshaft gear.

(5) Refer to paragraph 3–33 and install camshaft gear.

(6) Refer to paragraph 3–26 and install the timing gear cover.

Section VIII. FLYWHEEL AND RING GEAR

3–29. General

a. The flywheel is enclosed in the flywheel housing at the rear of the engine. It is directly driven by the engine crankshaft. Starting the engine is accomplished with the starter drive gear engaging the flywheel and rotating the engine until it starts.

b. The transmission torque converter is coupled to engine flywheel with a flexible plate. A drive adapter mounts on the engine flywheel and is attached to the flexible drive plate.

3–30. Flywheel and Ring Gear

a. Removal.

(1) Refer to paragraph 2–30 and remove the engine from the loader.

(2) Remove six bolts (fig. 3–48) securing flywheel (fig. 3–48) to engine crankshaft.

(3) Remove flywheel from engine using a suitable hoist if necessary.

(4) If flywheel ring gear (fig. 3–48) requires replacement, remove ring gear from flywheel as follows.

(*a*) Grind a notch through the ring gear at the root of one of the teeth. Do not damage flywheel when grinding.

(*b*) Expand ring gear and drive ring gear from flywheel.

b. Cleaning. Clean ring gear and flywheel in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

c. Inspection and Repair.

(1) Inspect ring gear for worn or broken teeth and other damage. Replace ring gear if unserviceable.

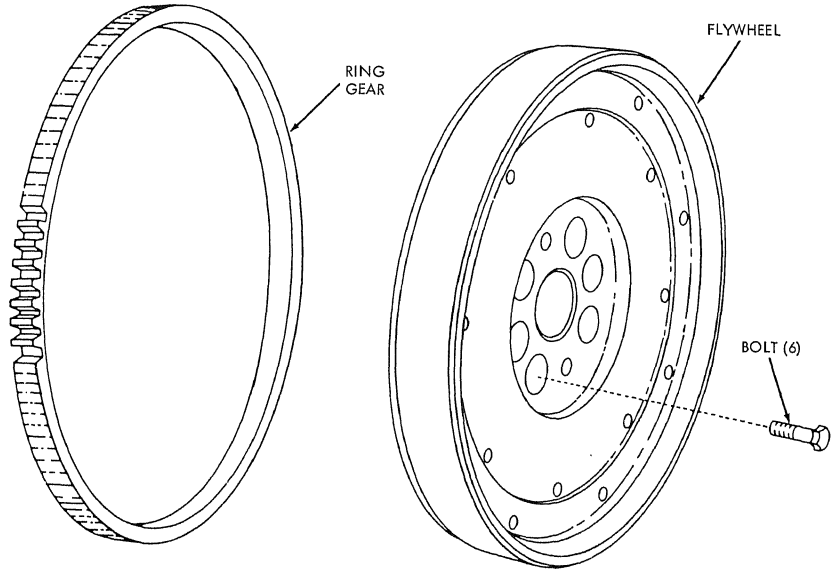


Figure 3–48. Flywheel and ring gear, exploded view.

(2) Inspect flywheel for cracks, damage, and elongated mounting holes. Replace flywheel if damaged beyond repair.

d. Installation.

(1) If ring gear (fig. 3–48) was removed from flywheel, install ring gear as follows.

(*a*) Heat ring gear evenly all around its circumference to 300 to 325° F. Ring gear should glow a dull red visible in the dark.

(*b*) Install ring gear on outer circumference of flywheel (fig. 3–48), with chamfered ends of teeth toward cylinder block.

(*c*) Drive ring gear down tight against shoulder. Allow ring gear to cool slowly. Do not cool with water.

(2) Install flywheel on crankshaft, using a suitable hoist if necessary. Secure flywheel with six bolts (fig. 3–48). Install flywheel carefully to protect oil seal in flywheel housing.

(3) Refer to paragraph 2–30 and install engine in loader.

3–31. Flywheel Housing

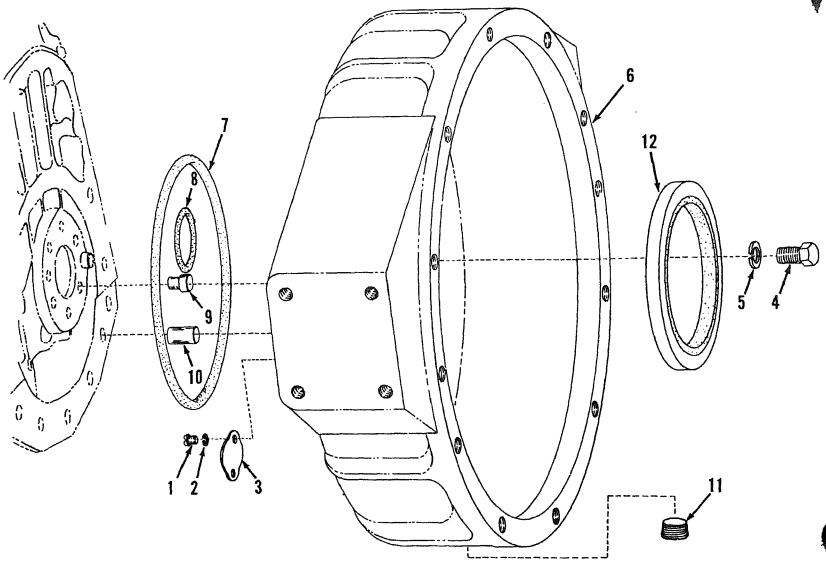
a. Removal.

(1) Refer to paragraph 2–30 and remove engine from loader.

(2) Refer to paragraph 3–30 and remove flywheel from engine. Do not remove ring gear unless replacement is necessary.

(3) Refer to paragraph 3–17 and disconnect rear flange of oil pan from flywheel housing.

(4) Remove eight screws (4, fig. 3–49) and lock washers (5) and remove flywheel



1 Screw, cap, hex-head, 1/4-20 x 5/8 in. (2 rqr)
2 Washer, lock, 1/4 in. (2 rqr)
3 Access hole cover
4 Screw, cap, hex-head, 1/2-13 x 1-1/4 in. (8 rqr)
5 Washer, lock, 1/2 in. (8 rqr)
6 Flywheel housing
7 Packing, preformed
8 Packing, preformed
9 Dowel pin (2 rqr)
10 Dowel pin (2 rqr)
11 Pipe plug
12 Oil seal

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Figure 3–49. Flywheel housing and oil seal, exploded view.

housing (6) from engine. Use a suitable hoist, if necessary.

(5) Remove and discard preformed packings (7 and 8).

(6) Place flywheel housing on a flat surface with inner side of housing up.

(7) Drive oil seal (12) from bore in housing with a suitable removal tool.

b. Cleaning. Clean flywheel housing in cleaning compound (Spec. P–S–661) and dry thoroughly with compressed air.

c. Inspection and Repair. Inspect flywheel housing for cracks, elongated holes, and damaged threads. Repair damaged threads if possible. Repair cracks by welding. Replace flywheel housing if it cannot be repaired.

d. Installation.

(1) Position oil seal (12, fig. 3–49) squarely in bore in flywheel housing (6) with sealing lip of seal toward engine block.

(2) Using a suitable oil seal installing

tool, carefully drive oil seal into bore until seal is seated against seal stop in bore.

(3) Install new preformed packings (7 and 8).

(4) Lubricate lip of oil seal with engine oil (OE). Install flywheel housing on engine, using a suitable hoist if necessary. Secure housing with eight screws (4) and lock washers (5).

(5) Refer to paragraph 3–17 and attach rear flange of oil pan to flywheel housing.

(6) Refer to paragraph 3–30 and install flywheel on engine.

(7) Refer to paragraph 2–30 and install engine in loader.

Section IX. CAMSHAFT AND BEARINGS

3–32. General

a. The camshaft is manufactured of a special high strength alloy steel. The lobes and journals are hardened and precision ground. The camshaft is installed in the lower left hand side of the cylinder block. The rear journal of the camshaft has a hole drilled through it to prevent hydrostatic lock between camshaft and flywheel housing.

b. A thrust plate between the camshaft gear and shoulder on front journal positions the camshaft in the cylinder block. The camshaft gear is positioned by a key in the camshaft and is a press fit on the camshaft.

c. Steel back, alloy lined, and tin plated bearings support the camshaft. The bearings have split-cinch butt joint. Bearings are of the precision type and do not require machining for the specified camshaft running clearance after installation. Lubrication is provided through oil passages from the main bearings.

3–33. Camshaft and Gear

a. Removal.

(1) Refer to paragraph 3–21 and remove the rocker arms and push rods.

(2) Refer to paragraph 3–17 and 3–18 remove the oil pan and oil pump.

(3) Refer to paragraph 3–26 and remove the timing gear cover.

(4) Check end play between camshaft gear and crankshaft gear (fig. 3–44). End play should be between 0.0015 and 0.0090. Replace gears if backlash between two mating gears exceed 0.0150 inch.

(5) Raise valve lifters away from camshaft in the following manner.

(*a*) Make up twelve wooden rods 16 inches long by 5/8 inch in diameter. Taper one end of rod slightly.

(*b*) Push wooden rods, tapered end first, through valve guides in cylinder head and into valve lifters, forcing tapered ends of rods into lifters.

(*c*) Pull wooden rods up from cylinder head to raise valve lifters to uppermost position. Secure wooden rods in this position with rubber bands, string, or wire to hold lifters away from camshaft.

(6) Rotate engine to position holes in camshaft gear (20, fig. 3–36) with bolts (19) securing thrust plate (21) to engine block.

(7) Remove three bolts (19) and remove camshaft and gear from engine block. As camshaft is removed, remove the thrust plate. If necessary, rotate camshaft to clear connecting rods while withdrawing camshaft.

(8) Install thrust plate between camshaft gear (fig. 3–50) and check clearance between thrust plate and camshaft bearing journal.

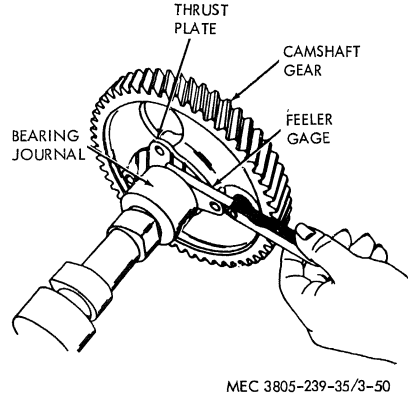


Figure 3–50. Checking camshaft thrust plate clearance.

(9) Clearance should be between 0.0030 to 0.0090 inch with a maximum of 0.0150 inch clearance. If clearance exceeds 0.0150 inch with a new end plate, the camshaft gear must be replaced.

(10) Using an arbor press or suitable gear puller, remove the camshaft gear from the camshaft. Remove key (22, fig. 3–36) from camshaft.

b. Cleaning. Clean camshaft and associated parts with cleaning compound solvent (Spec. P–S–661) and dry thoroughly with compressed air.

c. Inspection and Repair.

(1) Inspect camshaft for wear, scoring, nicks, and other damage. Check outside diameter of camshaft journals as illustrated on figure 3–51. Diameter should be from 2.1300 to 2.1310 inches. Inside diameter of camshaft, sleeve bearings should be 2.1330 to 2.1360 inches to provide a running clearance of 0.0020 to 0.0060 inch and clearance should not exceed 0.0080 inch.

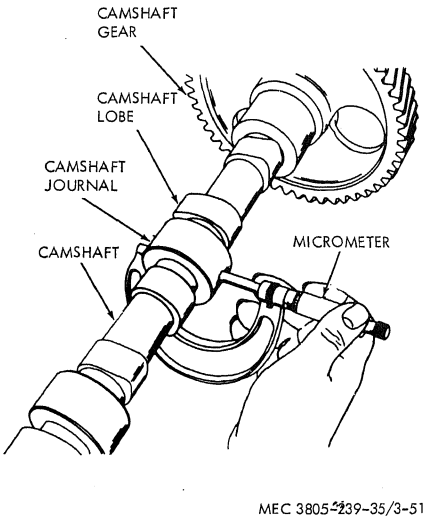


Figure 3–51. Checking camshaft bearing journal diameter.

(2) If journals are worn or scored enough to exceed this clearance, replace camshaft.

(3) Inspect lobes (fig. 3–51) on camshaft for roughness, scoring, and wear. Replace camshaft if lobes show any of these conditions.

(4) Inspect camshaft gear for nicked, scored, or broken teeth. Replace gear if these conditions exist.

(5) Inspect thrust plate for wear and damage. Check thickness of thrust plate. Thickness should be 0.2050 to 0.2060 inches. Replace thrust plates not conforming to these dimensions.

d. Installation.

(1) Install camshaft gear (20, fig. 3–36) on camshaft (23) in the following manner.

(*a*) Place camshaft in an arbor press with the first bearing journal supported on parallel bars.

(*b*) Heat the camshaft gear in oil to approximately 300° F. Coat camshaft gear ends with a mixture of white lead and engine oil (OE).

(*c*) Install key (22) in groove in camshaft. Use asbestos gloves to pick up gear and install on camshaft.

(*d*) Press gear on camshaft until gear hub is seated on shoulder on camshaft.

(2) Install thrust plate (fig. 3–50) on camshaft and check clearance. Clearance should be 0.0030 to 0.0090 inch.

(3) Lubricate camshaft bearings in cylinder block with engine oil (OE) and install camshaft in block. Use care in sliding camshaft through bearings so as not to scratch bearings.

(4) Position thrust plate (21, fig. 3–36) between gear and cylinder block before completely installing camshaft.

(5) Rotate camshaft gear to aline timing marks on gear with timing marks on crankshaft gear as illustrated on figure 3–44.

(6) Install screws (19, fig. 3–36) to secure thrust plate. Tighten screws to a torque of 18 to 20 foot-pounds.

(7) Check camshaft gear end play with a dial indicator. End play should be between 0.0030 to 0.0090 inch.

(8) Check backlash between camshaft gear and crankshaft gear. Backlash should be between 0.0015 to 0.0090 inch.

(9) Refer to paragraph 3–26 and install the timing gear cover.

(10) Refer to paragraphs 3–17 and 3–18 and install the oil pump and oil pan.

(11) Remove wooden rods from cylinder head to allow valve lifters to drop into contact with camshaft. Refer to paragraph 3–21 and install the push rods and rocker arms.

3–34. Camshaft Bearings

a. General. The camshaft bearings are removed and installed by using the new bearing to drive out the old bearing.

b. Removal and Installation. If inspection of camshaft bearings show they are worn or damaged, remove old bearing and install new bearings.

(1) Refer to paragraph 2–30 and remove the engine from the loader.

(2) Refer to paragraph 3–26 and remove the timing gear cover.

(3) Refer to TM 5–3805–239–12 and remove the starter.

(4) Refer to paragraph 3–30 and 3–31 and remove the flywheel and flywheel housing.

(5) Refer to paragraph 3–17 and 3–18 and remove the oil pan and oil pump.

(6) Refer to paragraph 3–21 and remove the rocker arms and push rods.

(7) Refer to paragraph 3–33 and remove the camshaft and gear.

(8) Using a camshaft bearing remover tool similar to the one illustrated on figure 3–52, remove the camshaft bearings in the following manner.

(*a*) The camshaft bearings must be positioned in the cylinder block with oil hole in bearing alined with oil hole in block.

(*b*) The front camshaft bearing must be installed with the front end of the bearing flush with or slightly recessed from the front side of the cylinder block.

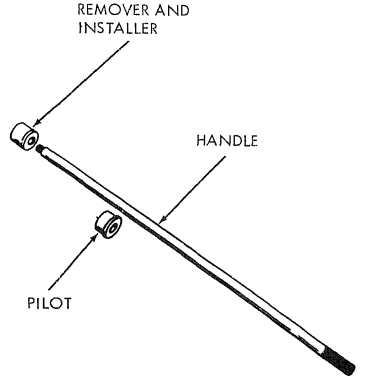
(*c*) The rear camshaft bearing must be installed with the rear face flush with or slightly recessed from the rear side of the cylinder block.

(*d*) The intermediate bearings should be installed to aline ends of bearings with sides of web.

(*e*) Install tool handle (fig. 3–52) through bearings as illustrated on figure 3–53.

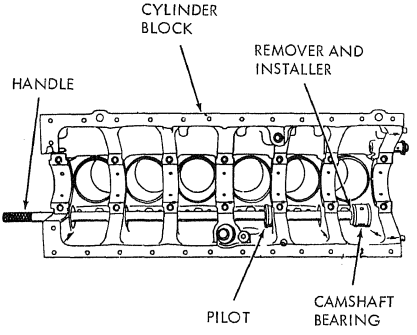
(*f*) Install pilot (fig. 3–52) and remover and installer tool on handle as illustrated on figure 3–53.

(*g*) Mark end of bearing and installing



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Figure 3–52. Typical camshaft bearing removing and installing tool.



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Figure 3–53. Camshaft bearings, removal and installation.

tool with chalk or crayon at position of oil hole. Mark cylinder block in the same manner at position of oil hole.

(*h*) Slide new bearing (fig. 3–53) on handle and position bearing against old bearing in block.

(*i*) Drive old bearing from bore with new bearing and tool.

Note. When new rear bearing is installed, old bearing will remain partly in cylinder block. Use a punch to collapse old bearing and remove old bearing. Finish driving new bearing in place if necessary.

(*j*) Install all new camshaft bearings as described above.

(9) Refer to paragraph 3–33 and install the camshaft and gear.

(10) Refer to paragraph 3–17 and 3–18 and install the oil pump and oil pan.

(11) Refer to paragraph 3–30 and 3–31 and install the flywheel housing and flywheel.

(12) Refer to paragraph 3–26 and install the timing gear cover.

(13) Refer to TM 5–3805–239–12 and install the starter.

(14) Refer to paragraph 3–21 and install the rocker arms and push rods.

(15) Refer to paragraph 3–30 and install the engine in the loader.

3–35. Valve Lifters

a. Removal.

(1) Refer to the following paragraphs and remove components.

(*a*) Remove engine from loader (para 2–30).

(*b*) Remove timing gear cover (para 3–26).

(*c*) Remove oil pan and oil pump (para 3–17 and 3–18).

(*d*) Remove rocker arms and push rods (para 3–21).

(*e*) Before removing camshaft rotate test stand to turn cylinder block on its side to retain valve lifters in block when camshaft is removed.

(*f*) Remove camshaft (para 3–33). Do not insert wooden rods in cylinder head.

(2) Remove valve lifters (24, fig. 3–36) from block. Tag each valve lifter as to location so lifters can be installed in their original location.

b. Cleaning. Clean valve lifters in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

c. Inspection and Repair.

(1) Check outside diameter of valve lifter stem. This dimension should be 0.7480 to 0.7485 inch.

(2) Inside diameter of bore in cylinder block should be 0.7495 to 0.7505 inch and fit of valve lifter in bore should be 0.0100 to 0.0025 inch. If clearance exceeds 0.0035 inch replace valve lifter.

(3) Inspect valve lifter faces which contact camshaft lobes for roughness, scuffing, and wear.

(4) Replace worn or damaged valve lifters.

d. Installation.

(1) Lubricate the valve lifters with engine oil (OE) and install lifters in original locations in the cylinder block.

(2) Refer to the following paragraphs and install the components.

(*a*) Install camshaft (para 3–33).

(*b*) Install rocker arms and push rods (para 3–21).

(*c*) Install oil pump and oil pan (para 3–17 and 3–18).

(*d*) Install timing gear cover (para 3–26).

(*e*) Install engine in loader (para 2–30).

Section X. CRANKSHAFT AND MAIN BEARINGS

3–36. General

a. The crankshaft has seven main bearings and is counterbalanced. The shaft is machined from a steel drop forging and is heat treated to assure maximum strength and durability. To assure a minimum of vibration the crankshaft is dynamically balanced. Thrust flanges at the center main bearing take up the end thrust of the crankshaft. Drilled passages in the crankshaft are provided for pressure lubrication from the main bearings to the connecting rod bearings.

b. The precision type main bearings support the crankshaft. The upper halves of the bear-

ing shells are seated in the cylinder block and the lower halves in the bearing caps. Bearing shells are fitted with tangs to prevent radial movement. Upper shells have two oil holes to allow oil flow.

3–37. Crankshaft

a. Removal.

(1) Refer to the following paragraphs to remove components.

(*a*) Remove engine (para 2–30).

(*b*) Remove starter (TM 5–3805–239–12).

(*c*) Remove flywheel and flywheel housing (para 3–30 and 3–31).

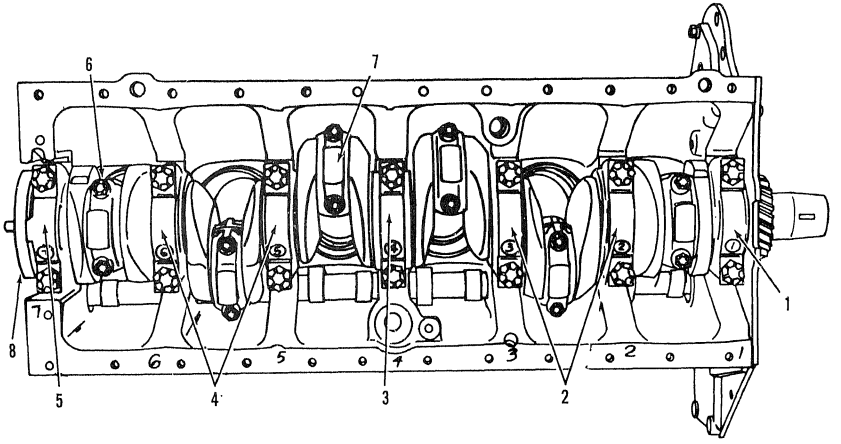
(*d*) Remove timing gear cover (para 3–26).

(*e*) Remove gear train (para 3–27) and front support plate (para 3–28).

(2) Refer to figure 3–54 and remove the crankshaft in the following manner.

(*a*) Mark each main bearing cap (1, 2, 3, 4, and 5) and connecting rod bearing cap (7) to facilitate installation in their original location.

(*b*) Remove twelve connecting rod screws (6) and remove six connecting rod caps (7) and connecting rod bearings.



1 Front main bearing cap
2 Intermediate main bearing cap (2 rqr)
3 Center main bearing cap
4 Intermediate main bearing cap (2 rqr)
5 Rear main bearing cap
6 Connecting rod screws (12 rqr)
7 Connecting rod bearing cap (6 rqr)
8 Crankshaft

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Figure 3–54. Crankshaft, removal and installation.

(*c*) Remove the screws securing the main bearing caps and remove the seven main bearing caps and lower main bearing shells (fig. 3–55).

(*d*) Remove the crankshaft from engine. Attach a rope and a suitable hoist, if necessary, to lift crankshaft.

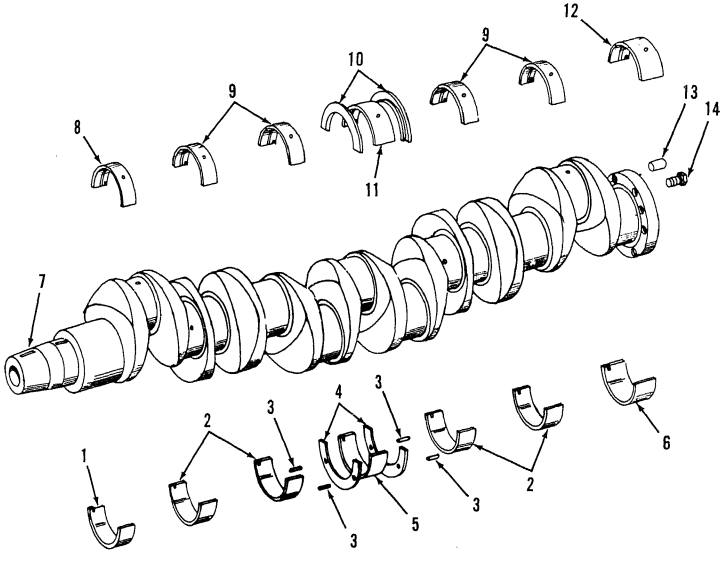
(*e*) Remove upper main bearing shells (fig. 3–55) from cylinder block.

(*f*) Remove pipe plug (14) from crankshaft.

b. Cleaning. Clean crankshaft with cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air. Blow out all passages in crankshaft with compressed air.

c. Inspection and Repair.

(1) Inspect crankshaft journals for scoring, chipping, cracking, or signs of overheat-



1 Front main bearing lower shell
2 Intermediate bearing lower shell (4 rqr)
3 Thrust flange pin (4 rqr)
4 Thrust flange (2 rqr)
5 Center main bearing lower shell
6 Rear main bearing lower shell
7 Crankshaft
8 Front main bearing upper shell
9 Intermediate bearing upper shell (4 rqr)
10 Thrust flange (2 rqr)
11 Center main bearing upper shell
12 Rear main bearing upper shell
13 Dowel pin
14 Pipe plug

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Figure 3–55. Crankshaft and main bearings, exploded view.

(2) Measure diameter of crankshaft main earing and connecting rod journals. The measurements should be as follows:

(*a*) Main bearing journals—3.2470 to 3.2480 inches.

(*b*) Connecting rod journals—2.7475 to 2.7485 inches.

(*c*) Measure journals at several places to check for out-of-round condition. Journals should not exceed 0.0020 inch out-of-round.

(*d*) Replace crankshaft if these dimensions and tolerances are not met.

d. Installation.

(1) Install pipe plug (14, fig. 3–55) in crankshaft.

(2) Install main bearing upper shells (fig. 3–55) in cylinder block in the same location from which they were removed. Install tangs on shells in slots in bearing seats.

Note. Refer to paragraph 3–38 and inspect main bearings before installation.

(3) Lubricate all crankshaft journals with engine oil (OE). Install crankshaft in cylinder block, using a hoist, if necessary.

(4) Install the main bearing lower shells (fig. 3–55) in their respective bearing caps.

(5) Install the two thrust flanges (10), without holes for pins, with oil grooves in flanges located next to the cheeks of the crankshaft, in the cylinder block.

(6) Install main bearing caps (fig. 3–54) in their locations with numbers on caps facing camshaft side of engine and corresponding to the number stamped on the lower edge of the cylinder block.

(7) Install and tighten main bearing cap bolts snugly. Force crankshaft in both directions to aline the caps with the upper protion of the main bearing bores.

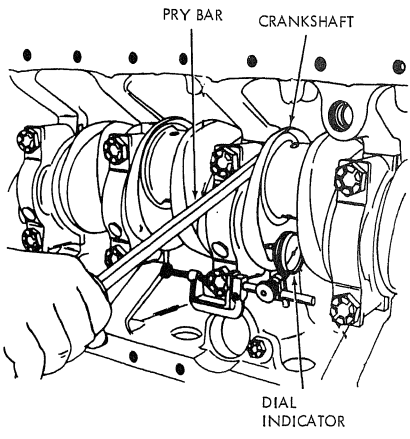
(8) Tighten main bearing cap bolts to a torque of 170 to 190 foot-pounds. Do not overtighten bolts. It may cause distortion of caps.

(9) Rotate crankshaft. Crankshaft should turn freely after bearing cap bolts are torqued.

(10) Check end play of crankshaft with a dial indicator as illustrated on figure 3–56.

(11) Tap crankshaft with a leather hammer in one direction to take up end play.

(12) Install dial indicator (fig. 3–56). Force crankshaft, with pry bar (fig. 3–56), in



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Figure 3–56. Checking crankshaft end play.

other direction and obtain end play reading on dial indicator.

(13) End play should be 0.0070 to 0.0130 inch and must not exceed 0.0210 inch. If end play is not within required limits disassemble center main bearing and crankshaft and replace thrust flanges (4 and 10, fig. 3–55).

(14) Attach connecting rods to crankshaft journals and install connecting rod bearing shells and caps.

Note. Refer to paragraph 3–41 and inspect connecting rod bearings before installation.

(15) Tighten connecting rod screws (6, fig. 3–54) to a torque of 65 to 70 foot-pounds.

(16) Check connecting rod side clearance with crankshaft journals. Clearance should be 0.0050 to 0.0100 inch.

(17) Refer to the following paragraphs to install components.

(*a*) Install front support plate (para 3–28) and gear train (para 3–27).

(*b*) Install timing gear cover (para 3–26).

(*c*) Install flywheel housing (para 3–31) and flywheel (para 3–30).

(*d*) Install starter (TM 5–3805–239–12).

(*e*) Install engine (para 2–30).

3–38. Main Bearing Caps and Main Bearings

a. Removal. Refer to paragraph 3–37 and remove the crankshaft, main bearing caps, and main bearings.

b. Cleaning. Clean all main bearings and caps with cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

c. Inspection and Repair.

(1) Inspect bearing shells for cracks, pits, scoring, and wear. Inspect backs of shells for bright spots which indicate shells have shifted.

(2) Install shells in cylinder block and bearing caps and install caps on block. Tighten cap bolts to specified torque.

(3) Measure inside diamter of bearing shells at a point 90° from the parting line. Do not measure at parting line as shells are a crush fit.

(4) Diameter should be 3.4990 to 3.5160 inches. Any reading above 3.5160 inches indicates wear.

(5) Measure outside diameter of corresponding bearing journal on crankshaft and subtract this from dimension obtained in step (4) above. This difference is crankshaft-to-bearing clearance. This clearance should be from 0.0019 to 0.0046 inch and should not exceed 0.0090 inch. If clearance exceeds this dimension install new bearings.

(6) Remove bearing caps and bearings.

(7) Bearing shells may also be measured by checking bearing shell thickness at a point 90° from the parting line. This dimension should be 0.1549 to 0.1554 inch. Bearing shells less than 0.1530 inch thick must be replaced.

(8) Replace bearing shells if scored, pitted, or shells which do not meet specifications listed above.

(9) Inspect bearing caps for cracks and damage to bearing surfaces. Replace caps that are cracked or damaged.

d. Installation. Refer to paragraph 3–37 and install crankshaft and bearing caps.

Section XI. PISTONS AND CONNECTING RODS

3–39. General

a. The pistons are tin-plated aluminum alloy and are precision machined, cam ground and balanced. Each piston has three compression rings and one oil control ring mounted in grooves. The top compression ring and the scraper segments of the oil control ring are chrome-plated. The oil ring groove contains holes to allow oil to drain back into the crankcase. Piston pins are of the full-floating type held in place by retaining rings.

b. The connecting rods are made of drop-forged, heat-treated steel. Rods are statically and electronically balanced. A hole in the upper end of the rod catches splashed oil from the cylinder block and allows it to flow into a radial groove in the connecting rod bearing for continuous piston pin lubrication. The split connecting rod bearings are held in place by the connecting rod cap. Mating surfaces of rod and cap are serrated to provide positive alinement and added strength.

3–40. Pistons and Piston Rings

a. Removal.

(1) Refer to the following paragraphs and remove components.

(*a*) Remove engine (para 2–30).

(*b*) Remove cylinder head (para 3–23).

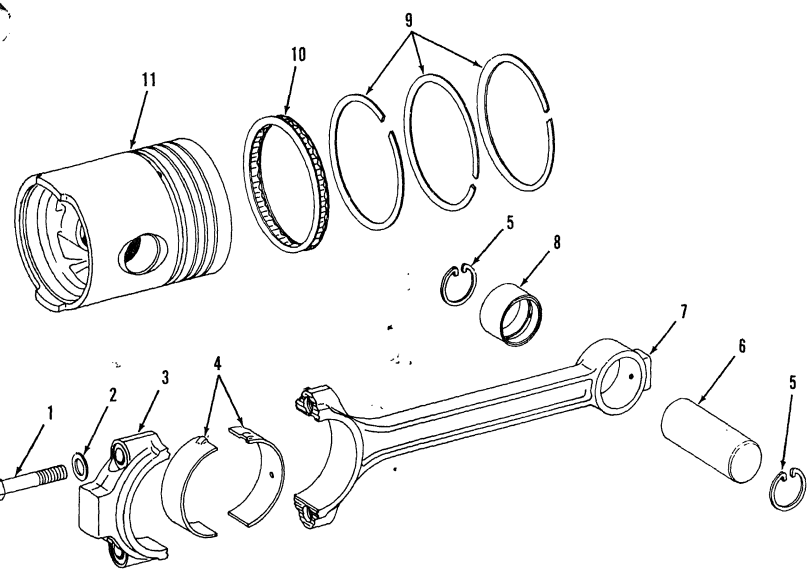
(*c*) Remove oil pan (para 3–17) and oil pump (para 3–18).

(2) Using a suitable tool remove piston ring travel ridge from inside of cylinder sleeve.

(3) Refer to paragraph 3–37 and disconnect connecting rod bearing caps from crankshaft. Remove bearing shells from bearing caps and connecting rods.

(4) Using a wooden handle, carefully push the pistons and connecting rods up and out through the top of cylinder sleeve.

(5) Remove retaining rings (5, fig. 3–57) from piston. Using piston pin driver, drive piston pin (6) from piston and connecting rod. Remove connecting rod from piston.



1 Connecting rod screw (2 rqr)
2 Washer (2 rqr)
3 Bearing cap
4 Bearing shell (2 rqr)
5 Ring, retaining (2 rqr)
6 Piston pin
7 Connecting rod
8 Sleeve bearing
9 Compression ring (3 rqr)
10 Oil control ring
11 Piston

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Figure 3–57. Piston and connecting rod, exploded view.

(6) Using piston ring pliers, remove oil ntrol ring (10) and three compression rings) from piston (11).

b. Cleaning. Clean piston and rings with aning compound, solvent (Spec. P–S–661) d dry thoroughly with compressed air. If rbon and gum deposits cannot be removed th solvent soak pistons and rings in carbon removing compound (MIL–C–5546A, FSN 6810–141–6526). Rinse parts in kerosene or hot water and remove softened carbon with a rag or soft brush. Clean oil drain holes in oil ring groove with a soft wire. Do not use hardened steel scraper on aluminum pistons.

c. Inspection and Repair.

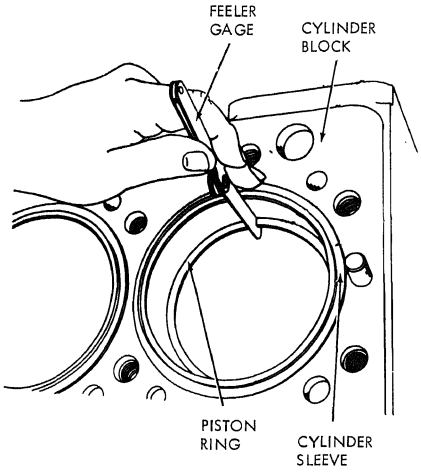
(1) Inspect piston ring skirt for score

marks, scratches, and cracks and for indications of improper piston clearance.

(2) Check diameter of skirt for wear. Skirt diameter, measured at right angles to piston pin and at bottom of skirt should be 4.2420 to 4.2430 inch.

(3) Measure inside diameter of cylinder sleeve (para 3–43).

(4) Difference between cylinder sleeve inside diameter and piston skirt outside diameter (step (2) above) provides the running clearance. This clearance should be 0.0065 to 0.0090 inch.



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Figure 3–58. Checking piston ring gap.

(5) Check gap between ends of piston rings by installing piston ring into cylinder in which it will be used as illustrated on figure 3–58. Use a piston to push ring squarely into sleeve.

(*a*) Check ring gap as illustrated on figure 3–58 with a feeler gage.

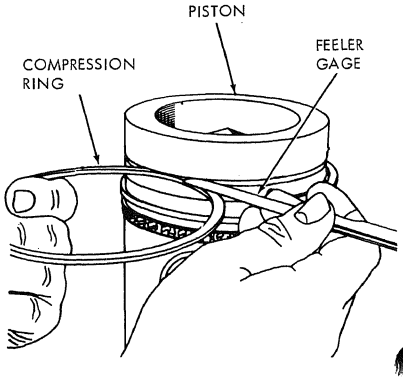
(*b*) Top compression ring (chrome plated) gap should be 0.0190 to 0.0340 inch.

(*c*) Second and third compression ring gaps should be 0.0150 to 0.0300 inch.

(*d*) Oil control ring (3 piece ring) gap should be 0.0130 to 0.0580 inch.

(*e*) Replace rings if ring gaps do not meet these tolerances.

(6) Check piston ring-to-groove clearance with a feeler gage as shown in figure 3–59.



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Figure 3–59. Checking piston ring-to-groove clearance.

(*a*) Top compression ring (chrome plated) clearance should be 0.0065 to 0.0080 inch.

(*b*) Second and third compression ring clearance should be 0.0030 to 0.0050 inch.

(*c*) Oil control ring (3 piece) clearance should be 0.0025 to 0.0085 inch.

(*d*) Replace rings and/or piston if clearances do not meet these tolerances.

(7) Measure outside diameter of piston pin. Diameter should be 1.5015 to 1.5017 inches. Measure inside diameter of connecting rod sleeve bearing. Diameter should be 1.5027 to 1.5032 inches. The clearance between pin and sleeve bearing should be 0.0010 to 0.0017 inch and must not exceed 0.0030 inch. Replace piston pin and/or sleeve bearing if clearance exceeds this dimension.

(8) Replace pistons, rings, and piston

pins if inspection and measurements prove them to be unserviceable.

d. Installation. Install piston on same connecting rod from which it was removed.

(1) Inspect connecting rod and bearings (para 3–41) before installing piston.

(2) Install piston rings (9 and 10, fig. 3–57) in grooves of piston (11). Install rings with side marked "TOP" or "T" toward top of piston. Use piston ring pliers to install rings.

Note. If piston is installed in vise, use lead or copper jaws to protect piston and connecting rod.

(*a*) Install stainless steel expander spacer of oil control ring in bottom groove on piston with ends of ring butted together.

(*b*) Install chrome plated steel segment in groove on bottom side of expander spacer. Install segment with gap in segment 90° from gap of expander spacer.

(*c*) Install remaining segment in groove on top of expander spacer. Install segment with gap in segment approximately 90° from expander spacer gap in opposite direction of bottom segment.

(*d*) Install three compression rings in grooves, with chrome plated ring in top groove. Gaps of all three rings should be positioned 180° apart and in line with piston pin holes.

(*e*) Check rings for free movement in grooves. A slight drag should be felt because of side sealing action of rings. Expander spacer end should remain in a butted position.

(3) Install one retaining ring (5) in piston pin hole in piston.

(4) Install upper end of connecting rod (7) in piston in line with piston pin holes. Lubricate piston pin (6) with engine oil (OE) and, using piston pin driver, tap piston pin through piston and connecting rod.

(5) Install remaining retaining ring (5) in piston pin hole.

(6) Lubricate piston and rings with engine oil (OE). Install piston ring compressor over piston and rings. Install piston and rod in same cylinder from which it was removed. Connecting rods and caps are numbered with number of cylinder. Numbered side of rod must be toward camshaft side of engine.

(7) Install connecting rod carefully down through sleeve, with ring compressor entering top of sleeve. Use a wooden handle to tap piston down into sleeve. Remove ring compressor.

(8) Lubricate connecting rod bearing shells with engine oil (OE) and install shells in connecting rod and connecting rod cap.

(9) Install connecting rod caps over crankshaft. Lubricate threads and under heads of connecting rod screws (1) with a thin coat of Molykote "G". Install screws and washers (2) through caps and tighten finger tight.

(10) Force rod and bearings endwise, first to the front and then to the rear to aline the rod and cap.

(11) Tighten screws alternately to a torque of 65 to 70 foot-pounds.

(12) Check side clearance between connecting rods and crankshaft journals. Clearance should be from 0.0050 to 0.0100 inch.

(13) Refer to the following paragraphs and install components.

(*a*) Install oil pump (para 3–18) and oil pan (para 3–17).

(*b*) Install cylinder head (para 3–23).

(*c*) Install engine (para 2–30).

3–41. Connecting Rods and Bearings

a. Removal. Refer to paragraph 3–40 and remove connecting rods and pistons and remove pistons from connecting rods.

b. Cleaning. Clean connecting rods and bearings in cleaning compound solvent (Spec. P–S–661) and dry thoroughly with compressed air. Clean oil hole in connecting rod with a soft wire.

c. Inspection and Repair.

(1) Check connecting rod and cap for cracks using a magnaflux method if available. If not check connecting rod for cracks with a magnifying glass and a strong light. Replace cracked connecting rods.

Note. Rods and cap must be replaced as a set. If one part is to be replaced, both must be replaced.

(2) Check alinement of piston pin bearing end with large bore end of connecting rod using a suitable direct reading alinement gage. If alinement is not to specifications, replace connecting rod.

(3) Check inside diameter of sleeve bearing. Diameter should be 1.5027 to 1.5032 inch. Clearance with piston pin should be 0.0010 to 0.0017 inch. If clearance exceeds 0.0030 inch, replace sleeve bearing.

(*a*) Press sleeve bearing from connecting rod using a suitable driver.

(*b*) Clean bore in rod and check for nicks, scoring, and other damage.

(c) Install new sleeve bearing in connecting rod. Aline oil hole in bearing with oil hole in rod and press bearing into rod, using a suitable driver, until holes are alined.

(d) Ream bearing to provide a inside diameter of 1.5027 to 1.5032 inch to provide correct running clearance. Clean bearing and rod after reaming.

(4) Inspect bearing shells for scoring, chipping, corrosion, cracks, or signs of overheating. Replace unserviceable bearing shells.

(5) Check bearing shells for wear. Install bearing shells in connecting rod and bearing cap. Install screws and tighten to a torque of 65 to 70 foot-pounds.

(6) Measure inside diameter of bearing. Diameter should be 2.7495 to 2.7510 inch. This should provide a running clearance with t crankshaft of 0.0010 to 0.0035 inch. Insta new bearing shells when clearance exceeds 0.0090 inch.

(7) Bearing shells may also be measured for thickness. Measure thickness at center of shell. Thickness should be 0.10975 to 0.11025 inch. Replace shells measuring less than 0.1080 inch.

d. Installation. Refer to paragraph 3–40 and install connecting rods and pistons.

Section XII. CYLINDER BLOCK AND CYLINDER SLEEVES

3–42. General

a. The cylinder block is a one-piece casting of cast iron. The block contains an oil gallery extending lengthwise through it. Passages direct oil from the main gallery to the main bearings and from the main bearings to the camshaft bearings in the block. Oil passages carry the oil to openings to which hoses are connected to carry the oil to the oil filters. A vertical drilled oil passage carries oil to the cylinder head and rocker arms. The oil is carried through the oil cooler before it enters the passages leading to the oil filters. Water jackets in the block surround the cylinder sleeves and carry the coolant from the radiator and water pump through the engine and out through the thermostat housings.

b. The removable wet-type cylinder sleeves are constructed of alloy cast iron. Two preformed packings, fitted into grooves in the lower outside of the sleeve to prevent coolant leakage into the oil pan. The flanged top of the sleeve fits into a recess in the top of the block. The cylinder head gasket and fire ring gaskets are compressed between this flange and the cylinder head. This pressure holds the sleeve in place and the gaskets serve as a coolant and pressure seal at the upper end of the sleeve.

3–43. Cylinder Sleeves

a. Inspection of Sleeve in Block. Inspect cylinder sleeve while installed in cylinder block in the following manner.

(1) Refer to the following paragraphs and remove the components.

(a) Remove engine (para 2–30).

(b) Remove cylinder head (para 3–23).

(c) Remove oil pan (para 3–17) and oil pump (para 3–18).

(d) Remove pistons and connecting rods (para 3–40).

(2) Use a suitable dial indicator and check sleeve for roundness. Use an inside micrometer to measure cylinder sleeve taper and wear.

(a) Inside diameter should be 4.2495 t 2.2510 inches. Measure at a position parallel to crankshaft and at right angles to crankshaft. Take measurements at several locations within the area of piston ring travel.

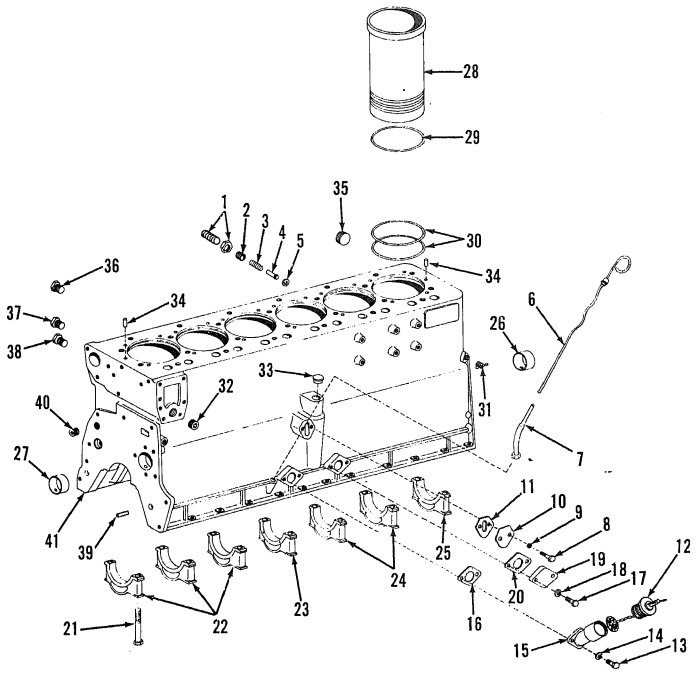
(b) Normal wear pattern will show maximum wear at the top three-fourths of piston travel. If sleeve wear does not exceed 0.0015 inch out-of-round, 0.0015 inch taper, or 0.0080 inch total wear and flange is not damaged and has specified protrusion, the sleeve may be considered serviceable.

(3) Inspect sleeve for cracks, scores, and other damage. Replace damaged sleeves.

(4) If sleeve is found to be serviceable, the ridge above ring travel must be removed. Use a ridge reamer tool to remove the ridge. After removing ridge, hone inside of cylinder to remove glaze in ring travel area. Do not overhone.

(a) Hone the sleeve in a cross hatch pattern at angles of 22° to 32° to a plane perpendicular to the bore axis.

(b) Remove only the glazed area of piston travel.



1 Adjusting screw
2 Spacer
3 Spring
4 Valve piston
5 Insert
6 Oil level gage
7 Adapter
8 Screw, cap, hex-head, 5/16-18 x 3/4 in. (2 rqr)
9 Washer, lock, 5/16 in. (2 rqr)
10 Plate
11 Gasket
12 Oil filler cap
13 Screw, cap, hex-head, 3/8-16 x 1-1/2 in. (2 rqr)
14 Washer, lock, 3/8 in. (2 rqr)
15 Oil filler elbow
16 Gasket
17 Screw, cap, hex-head, 3/8-16 x 7/8 in. (2 rqr)
18 Washer, lock, 3/8 in. (2 rqr)
19 Plate
20 Gasket
21 Bolt (14 rqr)
22 Bearing cap (3 rqr)
23 Bearing cap
24 Bearing cap (2 rqr)
25 Bearing cap
26 Camshaft bearing (5 rqr)
27 Camshaft bearing
28 Cylinder sleeve (6 rqr)
29 Preformed packing (12 rqr)
30 Shim (as rqr)
31 Drain cock
32 Pipe plug (5 rqr)
33 Pipe plug
34 Dowel pin (2 rqr)
35 Pipe plug
36 Pipe plug
37 Pipe plug
38 Pipe plug
39 Dowel pin (2 rqr)
40 Pipe plug
41 Cylinder block

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Figure 3–60. Cylinder block and cylinder sleeve, exploded view.

(*c*) Clean the sleeve thoroughly, after honing, with warm water and a detergent and scrub with a stiff bristle brush. Rinse and dry thoroughly.

(*d*) Check inside diameter of sleeve to be sure it is within tolerances stated above.

(*e*) Lubricate inside of sleeve with engine oil (OE).

b. Removal. If inspection ((*a*) above) indicates sleeve must be replaced remove sleeve as follows.

(1) Using a sleeve removal tool designed to engage bottom of sleeve, install tool through sleeve.

(2) Operate slide hammer of tool and remove sleeve (28, fig. 3–60) from cylinder block.

(3) Remove and discard preformed packings (29) from cylinder sleeve. Remove and tag shims (30) if present. Record amount of thickness of shims for installation.

c. Cleaning. Clean cylinder sleeve and bore in cylinder block with cleaning compound solvent (Spec. P–S–661) and dry thoroughly. Check bottom of sleeve flange and counterbore in cylinder block for cleanliness and freedom from nicks and burs.

d. Inspection and Repair.

(1) Insert sleeve in block without packings in place. Sleeve should slip into block and be free to rotate in block under hand pressure only.

(2) Construct a sleeve tool to check out-of-square of counterbore as follows.

(*a*) Take a new cylinder sleeve and mount it in a lathe. True the center line of the sleeve as closely as possible to the lathe center using dial indicators at each end of the sleeve.

(*b*) Check and machine bottom surface of sleeve flange to make it as true as possible to a 90° angle with the sleeve center line.

(*c*) Cut a V-section approximately one and one-half inches deep out of the top of the sleeve to allow dial indicator (fig. 3–61) to contact sleeve counterbore.

(*d*) Drill and tap two holes in sleeve and install a strap (fig. 3–61) to support dial indicator.

(3) Install sleeve tool and dial indicator as illustrated on figure 3–61 and rotate indicator to check out-of-square of counterbore. Total indicator reading should not exceed 0.0020 inch. If total exceeds this dimension, rework counterbore as follows.

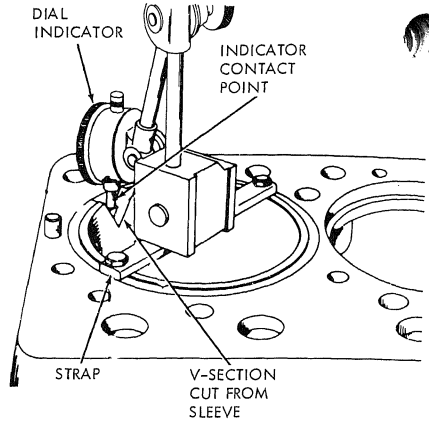


Figure 3–61. Checking out-of-square of sleeve counterbore.

(*a*) Use a sleeve reseating tool to cut counterbore in block.

(*b*) Clean top deck and counterbores in cylinder block thoroughly.

(*c*) Measure depth of counterbore. Depth should be 0.3150 to 0.3165 inch. Record depth.

(*d*) Install tool and cut counterbore. Make only a 0.0010 inch cut at a time. Take frequent micrometer readings to prevent cutting bore too deep.

(*e*) Measure thickness of sleeve flange at two or more locations. Thickness should be 0.3185 to 0.3200 inch.

(*f*) Cut only enough to square up counterbore. Measure depth of cut and install shims (30, fig. 3–60) as necessary to bring flange standout (height above cylinder block) to 0.0020 to 0.0050 inch.

(*g*) Install sleeve in cylinder and check height above block with a straightedge and feeler gage. Adjust height with shims if necessary. Remove sleeve.

e. Installation.

(1) Clean grooves in sleeve and install preformed packings (29, fig. 3–60) in grooves. Install packings dry.

(2) Coat lower sleeve bore in cylinder block with engine oil (OE).

(3) Use a cylinder sleeve installer to protect packings and install sleeve in installer tool on block.

(4) Push sleeve half-way through installer tool and remove both halves of installer tool from block.

(5) Push sleeve into block until fully seated in counterbore.

(6) Refer to the following paragraphs and install the components.

(*a*) Install pistons and connecting rods (para 3–40).

(*b*) Install oil pump (para 3–18) and oil pan (para 3–17).

(*c*) Install cylinder head (para 3–23).

(*d*) Install engine (para 2–30).

3–44. Cylinder Block

a. Removal.

(1) Refer to the following paragraphs and remove components.

(*a*) Remove engine (para 2–30).

(*b*) Refer to TM 5–3805–239–12 and remove accessories such as starter, generator, water pump, oil cooler, thermostat, air compressor, and oil pressure regulating valve.

(*c*) Remove cylinder head (para 3–23).

(*d*) Remove oil pan (para 3–17) and oil pump (para 3–18).

(*e*) Remove timing gear cover, gear train, and front support plate (para 3–25 through 3–28).

(*f*) Remove flywheel (para 3–30) and flywheel housing (para 3–31).

(*g*) Remove camshaft and gear, camshaft bearings, and valve lifters (para 3–33 through 3–35).

(*h*) Remove crankshaft (para 3–37).

(*i*) Remove pistons and connecting rods (para 3–40).

(*j*) Remove cylinder sleeves (para 3–43).

(2) Remove oil level gage (6, fig. 3–60) and adapter (7). Remove oil filler elbow (15) and gasket (16).

(3) Remove plates (10 and 19, fig. 3–60) and gaskets (11 and 20).

(4) Tag and remove all pipe plugs from block. If dowel pins require replacement, remove dowel pins.

b. Cleaning. Use high pressure steam containing a solvent to clean block and all oil and water passages in the block. Flush all oil passages with clean water to remove solvent. Clean water passages with the high pressure steam by rotating block while cleaning to wash out all loose scale. Dry thoroughly.

c. Inspection and Repair.

(1) Inspect block for cracks, rust, evidence of leakage, and any damage that may make block unserviceable.

(2) Rework cylinder sleeve counterbores and cylinder bores if necessary to maintain tolerances specified in repair and replacement standards.

(3) Replace all damaged or unserviceable blocks.

d. Installation.

(1) Install all pipe plugs in proper positions.

(2) Install new dowel pins in block by driving pins into proper holes.

(3) Install plates (10 and 19, fig. 3–60) and new gaskets (11 and 20).

(4) Install oil filler elbow (15) and new gasket (16). Install adapter (7) and oil level gage (6).

(5) Refer to the following paragraphs and install components.

(*a*) Install cylinder sleeves (para 3–43).

(*b*) Install pistons and connecting rods (para 3–40).

(*c*) Install crankshaft (para 3–37).

(*d*) Install camshaft and gear, crankshaft, and valve lifters (para 3–35 through 3–33).

(*e*) Install flywheel housing (para 3–31) and flywheel (para 3–30).

(*f*) Install timing gear cover, gear train, and front support plate (para 3–28 through 3–25).

(*g*) Install oil pump (para 3–18) and oil pan (para 3–17).

(*h*) Install cylinder head (para 3–23).

(*i*) Refer to TM 5–3805–239–12 and install pressure regulating valve, air compressor, thermostat, oil cooler, water pump, generator and starter.

(*j*) Install engine (para 2–30).

3–45. General

a. Engine tests include the checking of engine compression which may become necessary if the engine begins to lose power. Testing compression of the cylinders can indicate necessary engine repairs as covered in this chapter.

b. After the engine has been rebuilt or new sleeves, pistons, or piston rings have been installed, the engine should be run-in to allow the new parts to seat and function properly.

3–46. Compression Test

a. Normal Compression. Normal compression at 600 rpm and sea level conditions is 500 psi. To accurately evaluate compression test, the altitude at which the engine is located must be taken into consideration. For every 1000 feet of altitude subtract 3 percent from the 500 psi sea level figure.

b. Compression Readings. When taking compression readings a differential of 25 psi between one or more cylinders could indicate possible trouble. However, if the differential is 25 psi or more at 600 rpm but there is no evidence of excessive oil consumption, no leaking exhaust or intake valves, or loss of engine power, the engine can be continued in operation. If the above conditions exist or the difference between cylinders is 50 psi or more, the engine should be disassembled and a detailed inspection made of the cylinder head, valves, pistons and rings, and the cylinder sleeves and the necessary repairs made to eliminate the cause of low compression pressure.

c. Compression Test.

(1) To perform an accurate compression test the compression gage must be properly tested and calibrated.

(2) Start the engine and allow it to warm up to a minimum temperature of 160° F.

(3) Shut off the engine and disconnect fuel return manifold (tubes) from nozzle holder assemblies. Plug or connect a hose to the upper end of the tube assembly connecting the fuel return manifold to the overflow tee at the fuel injection pump (fig. 2–4). If hose is used, place lower end of hose in a container to collect fuel overflow from pump. Do not plug fuel return to fuel tank.

(4) Refer to paragraph 3–8 and remove injection nozzle and holder from No. 1 cylinder. Install compression tester adapter (fig. 3–62) in place of injection nozzle and holder as illustrated on figure 3–63.

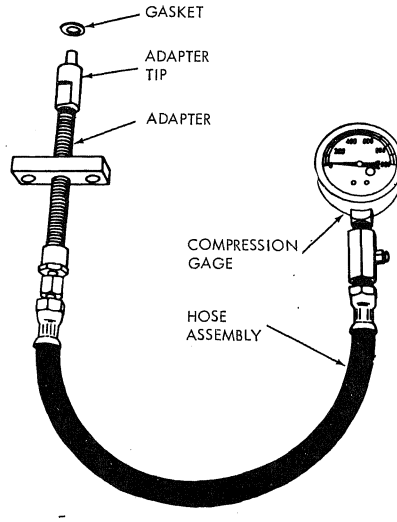


Figure 3–62. Cylinder compression kit.

(5) Start engine and run at approximately 600 rpm. Check compression pressure of No. 1 cylinder and record.

(6) Stop engine. Remove compression tester adapter from No. 1 cylinder. Install nozzle and holder assembly and connect fuel injection line to No. 1 cylinder nozzle.

(7) Repeat above procedure for the remaining cylinders and record all pressures.

(8) If pressures are low or a difference of 50 psi between cylinders is apparent, perform necessary repair functions to correct the condition.

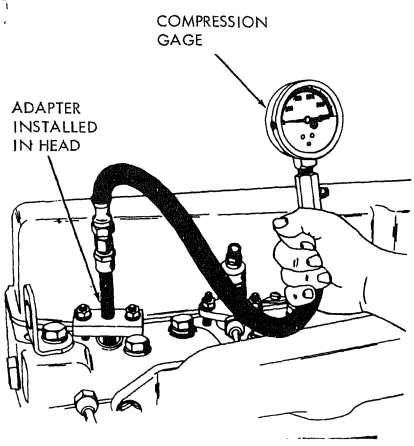


Figure 3–63. Checking compression pressure.

3–47. Engine Run-in Schedule

a. General. To allow the new parts installed in the engine to seat and function properly the degree to which the engine speed and load can be controlled. Avoid any prolonged periods of operation at idle speed or low load. Do not operate engine for sustained periods at maximum load for the first 24 hours.

b. Run-in Schedule.

(1) Start engine and run at ½ the rated speed with no load only long enough to be sure oil and coolant are circulating properly and that no leaks are evident.

(2) Operate the engine at varying speeds with light to medium loads for 2 to 4 hours.

(3) Place the engine in normal service, but at reduced loads, for the next 24 hours of running time. Avoid allowing the engine to lug or labor and avoid any sustained full load operation.

(4) Maintain a close check on operating pressures and temperatures. Stop the engine and check any large deviation from the normal before continuing. Inspect the engine at frequent intervals for secure mounting of parts and correct any deficiencies which become evident.

(5) Place the engine and loader into normal service.





CHAPTER 4

TRANSMISSION REPAIR INSTRUCTIONS

Section I. GENERAL

4–1. Description

a. The transmission is a two speed forward, one reverse, torque converter, planetary gear type. The two turbine torque converter is directly driven by the engine crankshaft and is coupled by gears to a forward planetary gear set, a reverse gear set and a direct drive clutch. Driven elements of the three units are connected to output transfer gears driving output shafts extending forward and to the rear of the transfer case.

b. Ranges are selected by a single manual control mounted on the steering column which has selector positions at neutral (N), forward–1 (LF), forward–2 (HF) and reverse (R). Forward–1 engages forward range clutch (11, fig. 4–1), forward–2 engages direct drive or high range clutch (13), and reverse engages the reverse range clutch 9.

c. A charging oil pump (7) furnishes oil flow and oil pressure for the entire transmission. The pump is operating at any time the engine is running. Oil is carried to the pump from the transmission sump by a suction tube. Oil from the pump is delivered through passages to the control valve and other locations. Before the oil enters the suction tube it must pass through a strainer. The strainer is accessible for cleaning.

4–2. Operation

a. Oil under pressure from the transmission oil charging pump (7, fig. 4–1) is directed through the manual selector valve to the converter turbines and planetary gear clutches. Controlled oil flow within the converter provides stepless multiplication of engine torque as engine speed increases. Additional multiplication is obtained by applying the forward range clutch (11) or reverse range clutch (9) to direct converter output through the forward reduction or reverse reduction planetary gear sets (LF and R ranges). Higher vehicle road speeds are obtained by releasing the forward range clutch (11) and applying the direct drive clutch (13) for 1:1 transmission of converter output (HF range).

b. The control valve assembly regulates transmission lubrication and operating pressures and controls clutch application pressures and rate of clutch application. A cutoff valve within the control valve assembly releases any applied clutch when the operator depresses the brake pedal. The cutoff valve permits immediate application of full engine power to the vehicle hydraulic system. Releasing the brake pedal allows the selected clutch to return to operation.

Section II. TRANSMISSION REPAIR INSTRUCTIONS

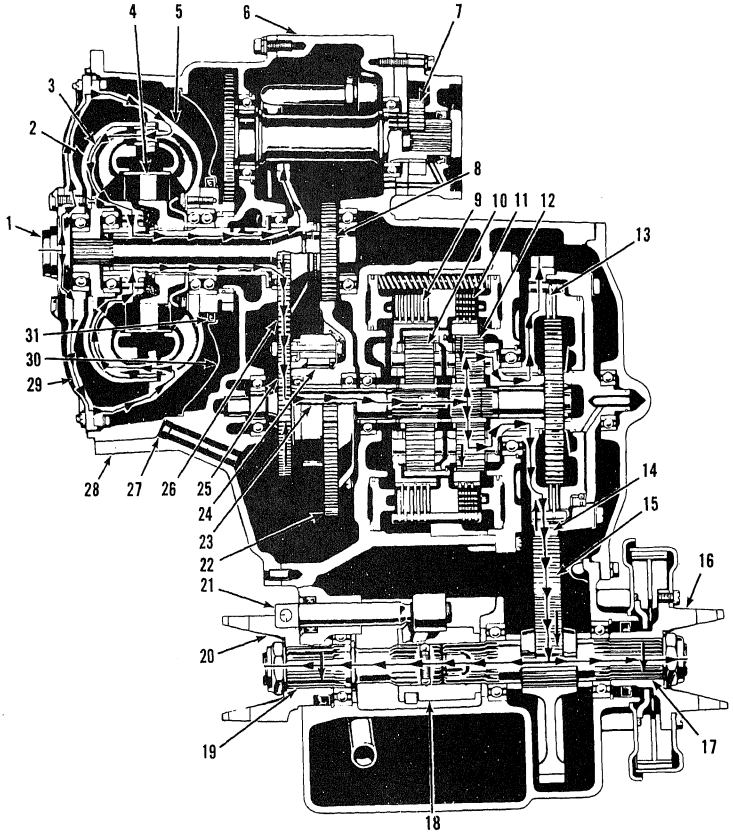
4–3. General

a. Repair of the transmission is contained in this section. As far as is possible the transmission components will be removed, repaired, and installed within their own sub-paragraphs.

b. Complete disassembly and repair of the transmission will be accomplished in this manner, with references to preceding sub-paragraphs for removal and installation procedures to avoid repetition.

4–4. Transmission

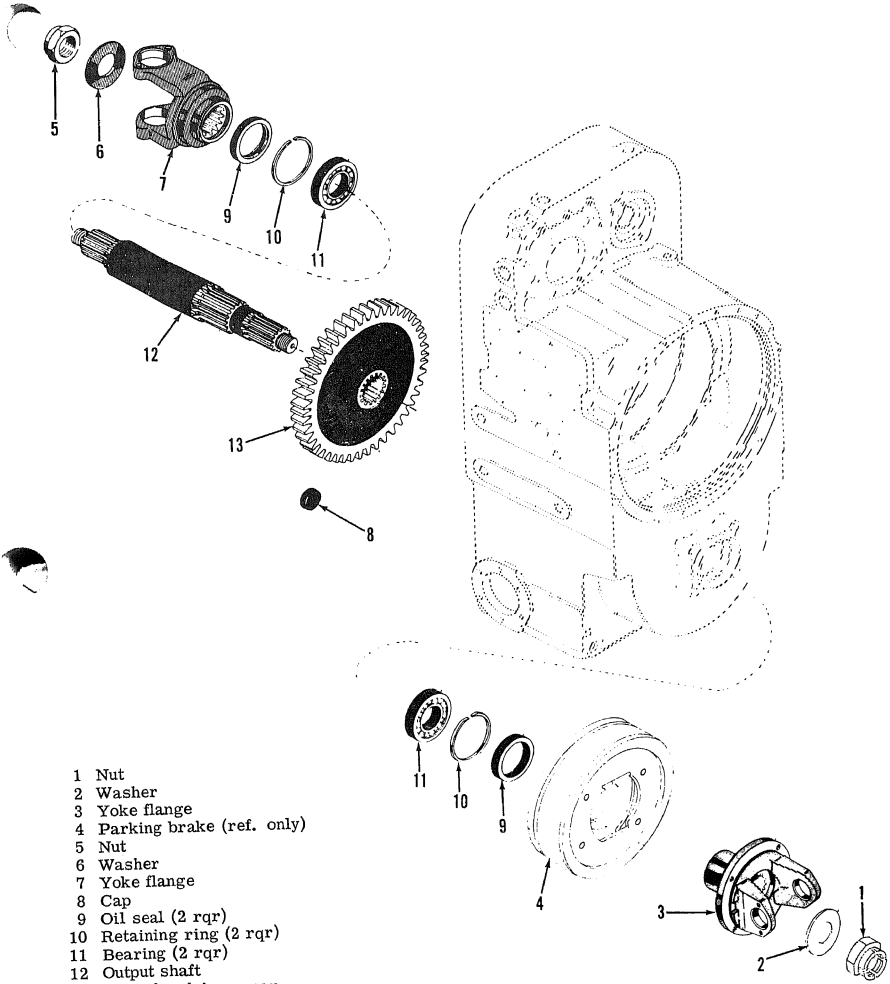
a. Removal. Refer to paragraph 2–31 and remove the transmission from the loader. Refer to TM 5–3805–239–12 and drain transmission.



1 Torque converter drive shaft
2 First turbine
3 Second turbine
4 Stator
5 Converter pump
6 Transmission main housing
7 Oil charging pump assembly
8 First turbine drive gear
9 Reverse - range clutch
10 Reverse - range planetary
11 Forward - range clutch
12 Forward - range planetary
13 Direct drive clutch
14 Transfer drive gear
15 Transfer driven gear
16 Front output flange
17 Front output shaft
18 Disconnect splined collar
19 Rear output shaft
20 Rear output flange
21 Disconnect shifter shaft
22 First turbine driven gear
23 Range gear input shaft - (second turbine driven gear)
24 Freewheel clutch
25 Second turbine driven gear
26 Second turbine drive gear
27 Pipe plug
28 Converter housing
29 Converter pump cover
30 Converter diaphragm
31 Oil seal

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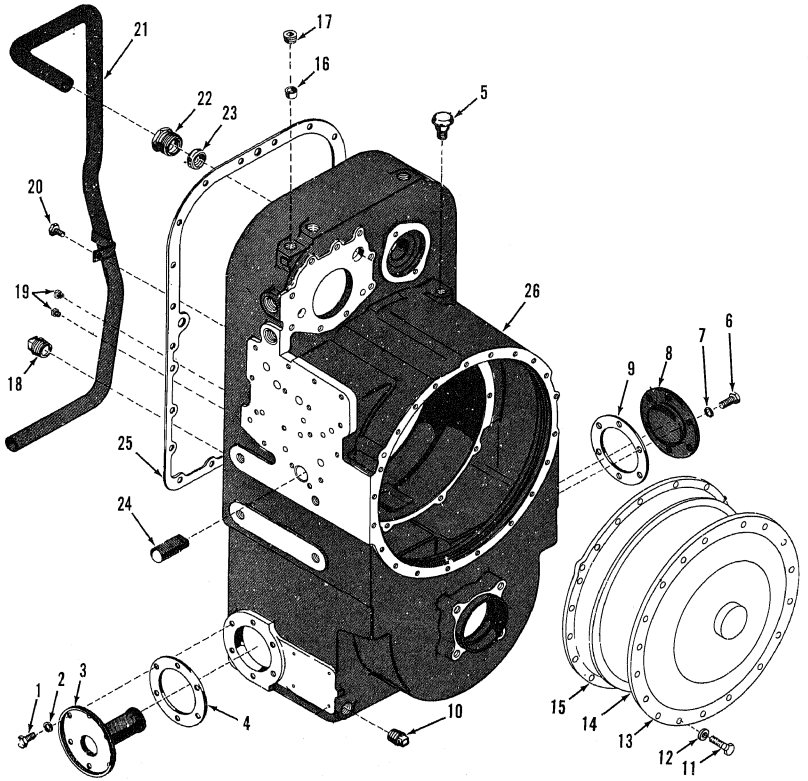
Figure 4–1. Transmission, cutaway view.



1 Nut
2 Washer
3 Yoke flange
4 Parking brake (ref. only)
5 Nut
6 Washer
7 Yoke flange
8 Cap
9 Oil seal (2 rqr)
10 Retaining ring (2 rqr)
11 Bearing (2 rqr)
12 Output shaft
13 Transfer driven gear

MEC 3805-239-35/4-2

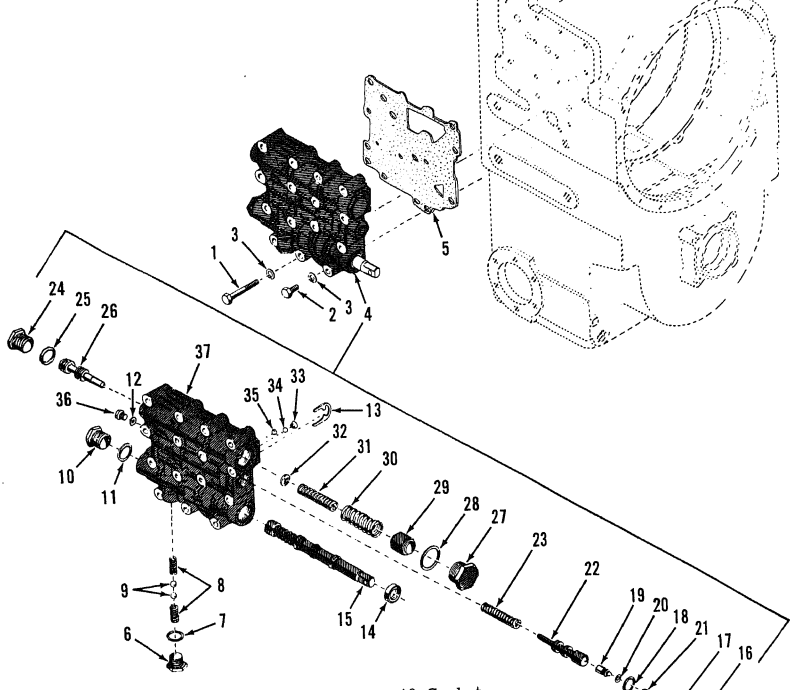
Figure 4-2. Transmission output group, exploded view.



1 Screw, cap, hex-head, 3/8-16 x 7/8 in. (6 rqr)
2 Washer, lock, 3/8 in. (6 rqr)
3 Strainer
4 Gasket
5 Breather
6 Screw, cap, hex-head, 3/8-16 x 7/8 in. (6 rqr)
7 Washer, lock, 3/8 in. (6 rqr)
8 Cover
9 Gasket
10 Drain plug
11 Screw, cap, hex-head, 3/8-16 x 1-1/8 in. (19 rqr)
12 Washer, lock, 3/8 in. (19 rqr)
13 Rear cover
14 Seal ring
15 Gasket
16 Plug
17 Pipe plug
18 Pipe plug
19 Pipe plug (2 rqr)
20 Screw, cap, hex-head, 3/8-16 x 5/8 in.
21 Suction tube
22 Tube nut
23 Seal ring
24 Anchor pin
25 Converter housing gasket
26 Transmission housing

MEC 3805-239-35/4-3

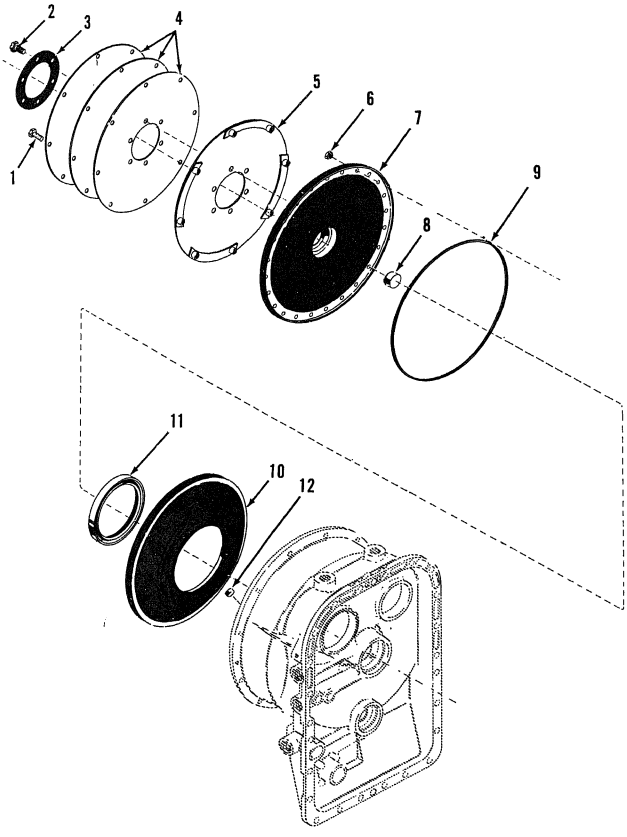
Figure 4-3. Transmission housing, covers, and strainer, exploded view.



1 Screw, cap, hex-head, 3/8-16 x 2-1/2 in.
2 Screw, cap, hex-head, 3/8-16 x 1 in. (15 rqr)
3 Washer, lock, 3/8 in. (16 rqr)
4 Control valve assembly
5 Gasket
6 Plug
7 Gasket
8 Detent spring (2 rqr)
9 Detent ball (2 rqr)
10 Plug
11 Gasket
12 Gasket
13 Valve stop
14 Oil seal
15 Range selector valve
16 Plug
17 Cutoff valve plug
18 Gasket
19 Plug
20 Preformed packing
21 Cup
22 Clutch cutoff valve
23 Valve spring
24 Plug
25 Gasket
26 Regulator valve
27 Plug
28 Gasket
29 Plug
30 Outer spring
31 Inner spring
32 Spring retainer
33 Plug
34 Ball
35 Plug
36 Valve body

MEC 3805-239-35/4-4

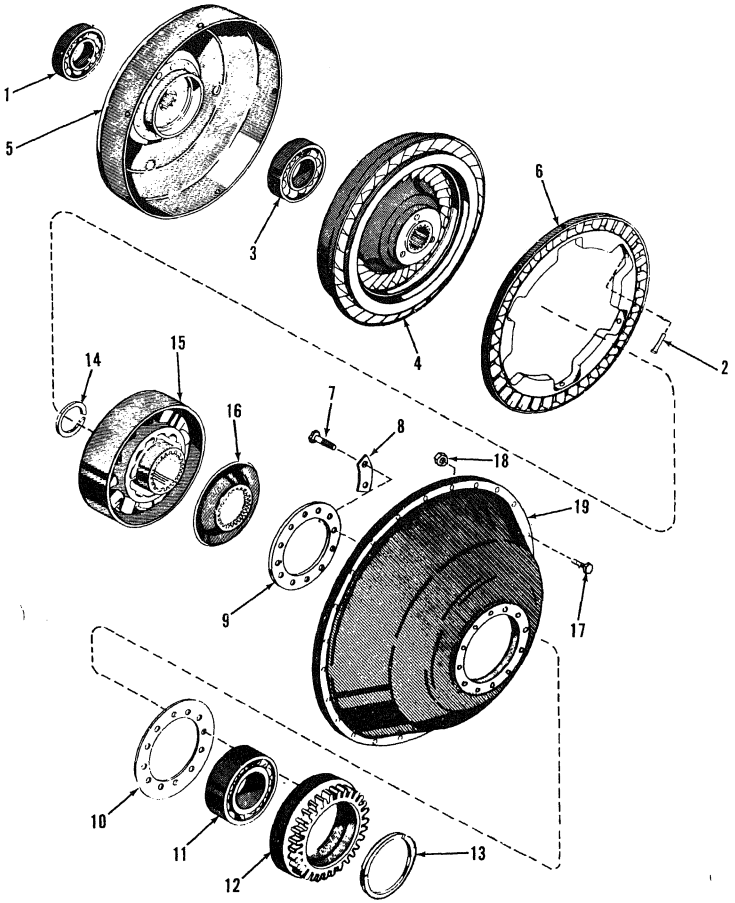
Figure 4-4. Transmission control valve, exploded view.



1 Bolt (6 rqr)
2 Screw, cap, 1/2-13 x 1 in. (6 rqr)
3 Retaining plate
4 Flexible disk (3 rqr)
5 Disk assembly
6 Nut (24 rqr)
7 Pump cover
8 Plug
9 Preformed packing
10 Converter diaphragm
11 Oil seal
12 Plug

MEC 3805-239-35/4-5

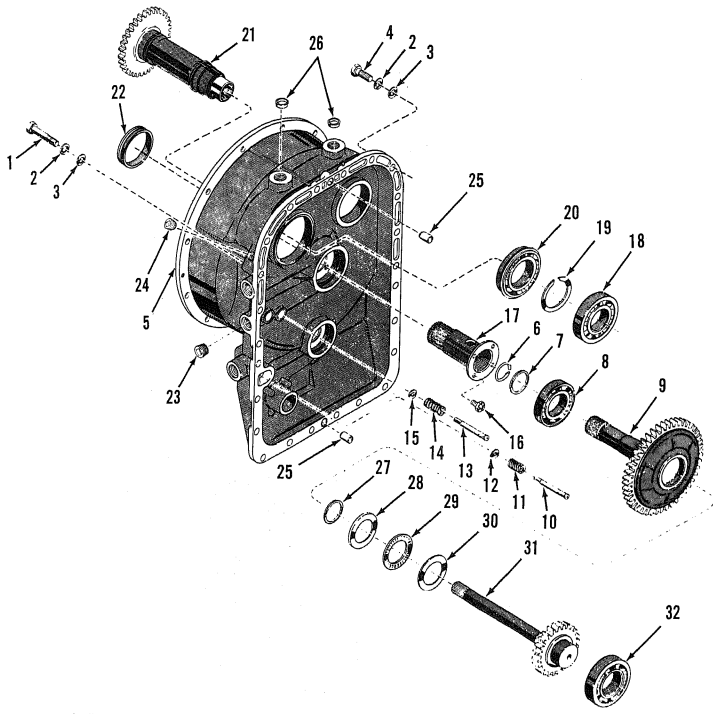
Figure 4-5. Flexible disks and diaphragm, exploded view.



1 Bearing
2 Pin (9 rqr)
3 Bearing
4 Second turbine
5 First turbine support
6 Turbine support
7 Screw, self-locking, 1/4-28 x 1-1/4 in. (12 rqr)
8 Locking strip (6 rqr)
9 Pump retainer
10 Gasket
11 Bearing
12 Drive gear
13 Oil seal
14 Retaining ring
15 Convertor stator
16 Spacer
17 Screw, cap, hex-head, 5/16-24 x 1-3/8 in. (24 rqr)
18 Nut, 5/16-18 (24 rqr)
19 Pump assembly

MEC 3805-239-35/4-6

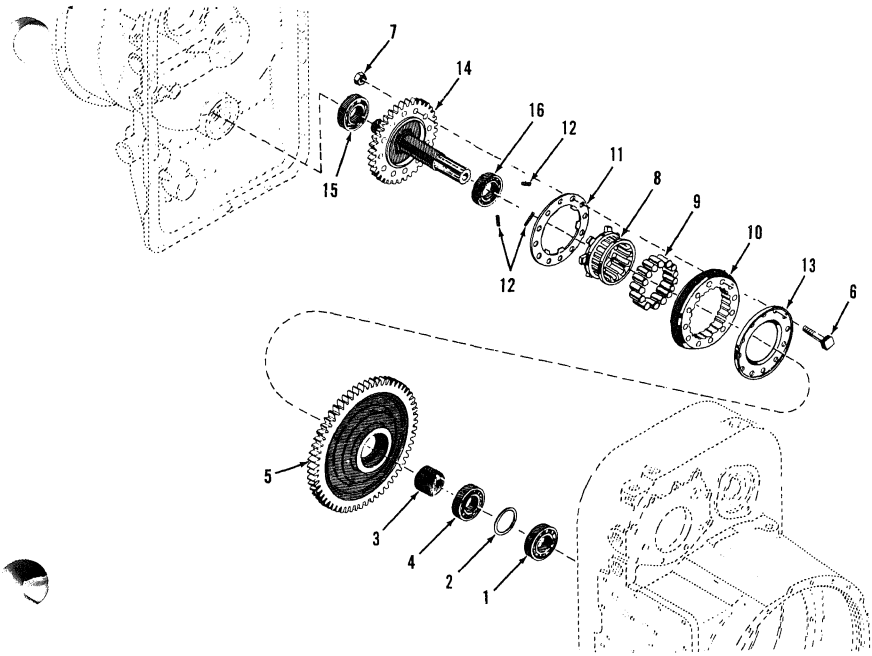
Figure 4-6. Transmission torque converter, exploded view.



1 Screw, cap, hex-head, 7/16-14 x 2-3/4 in.
2 Washer, lock, 7/16 in. (24 rqr)
3 Washer, flat, 7/16 in. (24 rqr)
4 Screw, cap, hex-head, 7/16-14 x 1-3/8 in. (23 rqr)
5 Converter housing
6 Ring, retaining
7 Packing, preformed
8 Bearing
9 Second turbine drive gear
10 Guide pin
11 Spring
12 Lube regulator valve
13 Guide pin
14 Spring
15 Converter regulator valve
16 Screw, cap, hex-head, 5/16-18 x 3/4 in. (4 rqr)
17 Ground sleeve
18 Bearing
19 Ring, retaining
20 Bearing
21 Accessory driven gear
22 Sleeve bearing
23 Pipe plug
24 Pipe plug
25 Dowel pin (2 rqr)
26 Plug (2 rqr)
27 Packing, preformed
28 Thrust race
29 Thrust roller bearing
30 Thrust race
31 First turbine drive gear
32 Bearing

MEC 3805-239-35/4-7

Figure 4-7. Torque converter housing and turbine drive gears, exploded view.



1 Bearing
2 Spacer
3 Spacer
4 Bearing
5 First turbine driven gear
6 Screw, cap, hex-head, 3/8-24 x 3 in. (12 rqr)
7 Nut, self-locking, 3/8-24 (12 rqr)
8 Roller cage
9 Roller (15 rqr)
10 Freewheel cam
11 Spring plate
12 Spring (3 rqr)
13 Oil collector
14 Second turbine driven gear
15 Bearing
16 Bearing

MEC 3805-239-35/4-8

Figure 4–8. Turbine driven gears and freewheel unit, exploded view.

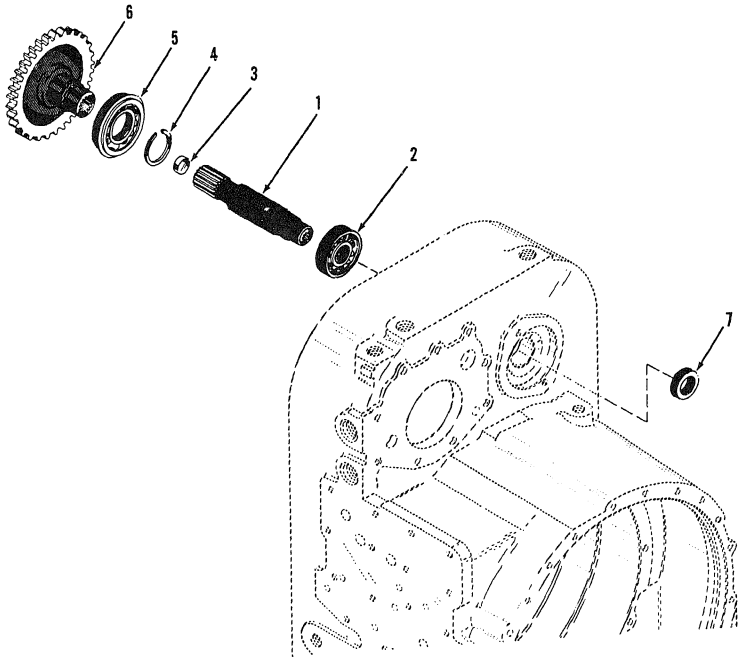
b. Disassembly of Transmission.

(1) Refer to TM 5–3805–239–12 and remove rear yoke flange (3, fig. 4–2) and parking brake.

(2) Refer to TM 5–3805–239–12 and remove the oil strainer assembly (3, fig. 4–3).

(3) Remove sixteen screws (1 and 2, fig. 4–4) and lockwashers (3) and remove control valve assembly (4) and gasket (5).

(4) Turn transmission on bench so that housing rests on front surface.



1 Accessory drive shaft
2 Bearing
3 Plug
4 Ring, retaining
5 Bearing
6 Accessory drive gear
7 Oil seal

MEC 3805-239-35/4-9

Figure 4–9. Accessory drive gear and drive shaft, exploded view.

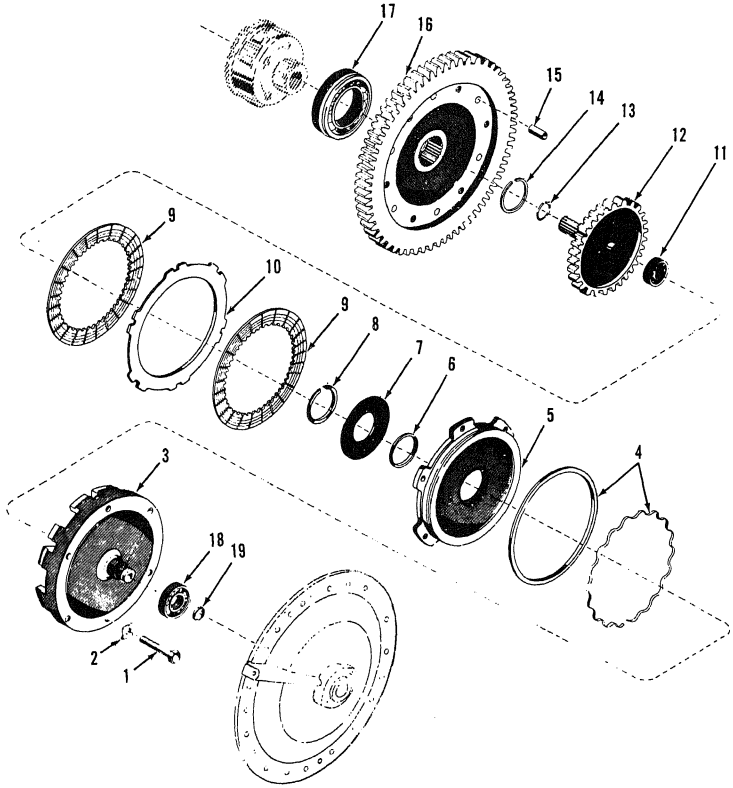
(5) Remove six screws (2, fig. 4–5), retaining plate (3), three flexible disks (4) and disk assembly (5).

(6) Remove 24 nuts (6) securing pump cover (7) to turbine housing.

(7) Install two screws (2) in cover holes 180° apart and use screws as pullers to remove cover. Remove preformed packing (7). Do not remove ball bearing from cover unless replacement is necessary. Drive or press ball bearing from cover to remove.

(8) Use two screwdrivers or steel rods to lift turbine assembly from housing.

(9) Remove retaining ring (14, fig. 4–6)



1 Screw, cap, hex-head, 1/2-20 x 2-3/4 in. (6 rqr)
2 Lock tab (6 rqr)
3 Housing
4 Seal and expander
5 Piston
6 Packing, preformed
7 Return spring
8 Ring, retaining
9 Clutch plate (2 rqr)
10 Clutch plate
11 Bearing
12 Clutch hub
13 Ring, retaining
14 Ring, retaining
15 Pin (6 rqr)
16 Transfer drive gear
17 Bearing
18 Bearing
19 Packing, preformed

MEC 3805-239-35/4-10

Figure 4–10. Direct drive clutch and transfer drive gear, exploded view.

from converter ground sleeve. Remove stator (15) and spacer (16).

(10) Bend lock strips (8) and remove four screws (7) securing converter pump to drive gear (12). Remove pump (19), bearing (11), drive gear (12), retainer (9) and gasket (10) from the transmission as an assembly. Use specially designed tool (fig. 2–1) to remove pump and components.

(11) Remove 24 screws (1 and 4, fig. 4–7), lock washers (2) and flat washers (3) securing converter housing (5) to the transmission.

(12) Attach a suitable sling to converter housing and lift housing from transmission. Remove gasket (25, fig. 4–3) from housing.

(13) Remove retaining ring (6), packing (7), bearing (8) and second turbine drive gear (9) from transmission.

(14) Refer to figure 4–8 and remove turbine freewheel unit, first turbine driven gear, and second turbine driven gear as a unit from transmission.

(15) Remove accessory drive shaft (1, fig. 4–9) and bearing (2) from transmission.

(16) Do not remove bearing from shaft unless replacement is necessary. Do not remove plug from shaft. To remove bearing, drive bearing from shaft.

(17) Remove 19 screws (11, fig. 4–3). Use two of the screws in puller holes provided and force cover (13) from housing. Remove seal ring (14) and gasket (15).

(18) Bend lock tabs (2, fig. 4–10) away from screws (1) and remove six screws.

(19) Use two screwdrivers to remove housing (3), piston (5) and hub (12). Remove two clutch plates (9) and one clutch plate (10).

(20) Remove retaining ring (14). Remove transfer drive gear (16) from forward planetary gear assembly. Do not remove pins (15) or bearing (17) unless replacement is necessary. Press pins from gear to remove pins. Pull bearing from gear hub to remove.

(21) Remove 10 screws (1, fig. 4–11) and remove housing (2) and piston (4). Release spring tension evenly around housing to remove.

(22) Remove 12 spring pins (1, fig. 4–12) and 12 clutch return springs (2) from clutch anchor assembly.

(23) Remove two clutch plates (7, fig. 4–11) and two plates (8). Remove forward ring gear (9). Remove forward carrier (11) and reverse ring gear (19).

(24) Remove clutch anchor (11, fig. 4–12). Remove reverse planetary carrier assembly (3) and clutch plates (12 and 13).

(25) Remove seal rings (16 and 17).

(26) Remove nine screws (1 and 2, fig. 4–13) and lock washers (3) and remove oil pump assembly (4) and gasket (5).

c. Cleaning.

(1) Clean all parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

(2) Clean all oil passages with a soft wire cleaning to make certain they are clean.

(3) Examine parts thoroughly after and flush with solvent. Blow out with compressed air.

(4) Clean bearings with solvent, soaking them in the solvent if necessary. Do not dry bearings with compressed air.

(5) Keep bearings covered and greased until ready to be installed.

d. Inspection and Repair.

(1) Inspect all castings and machined surfaces for wear, grooves, scratches, and dirt. Remove scratches and burs with crocus cloth. Replace parts that have deep grooves or scratches.

(2) Inspect all oil passages to be positive they are clean and clear. Clean if necessary.

(3) Inspect all mounting faces for burs, scratches, nicks, and foreign matter. Remove defects with crocus cloth or a soft stone. Replace unserviceable parts.

(4) Inspect all threaded holes for damaged threads. Repair threads with a thread chaser if possible.

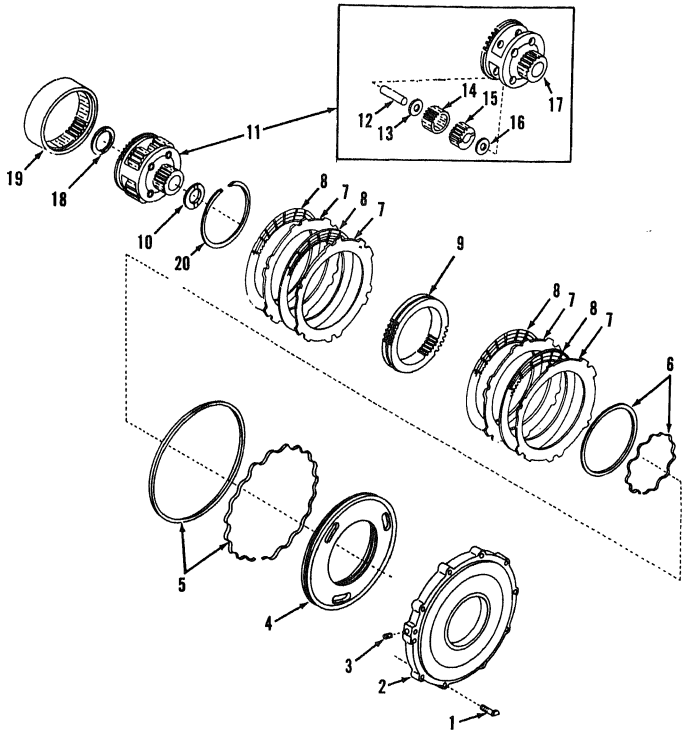
(5) Inspect machine surfaces for damage that may cause oil leaks. Repair parts, if possible, or replace parts.

(6) Replace all cracked or damaged castings.

(7) Inspect bearings as follows:

(*a*) Check bearing rotation. Replace any rough bearings.

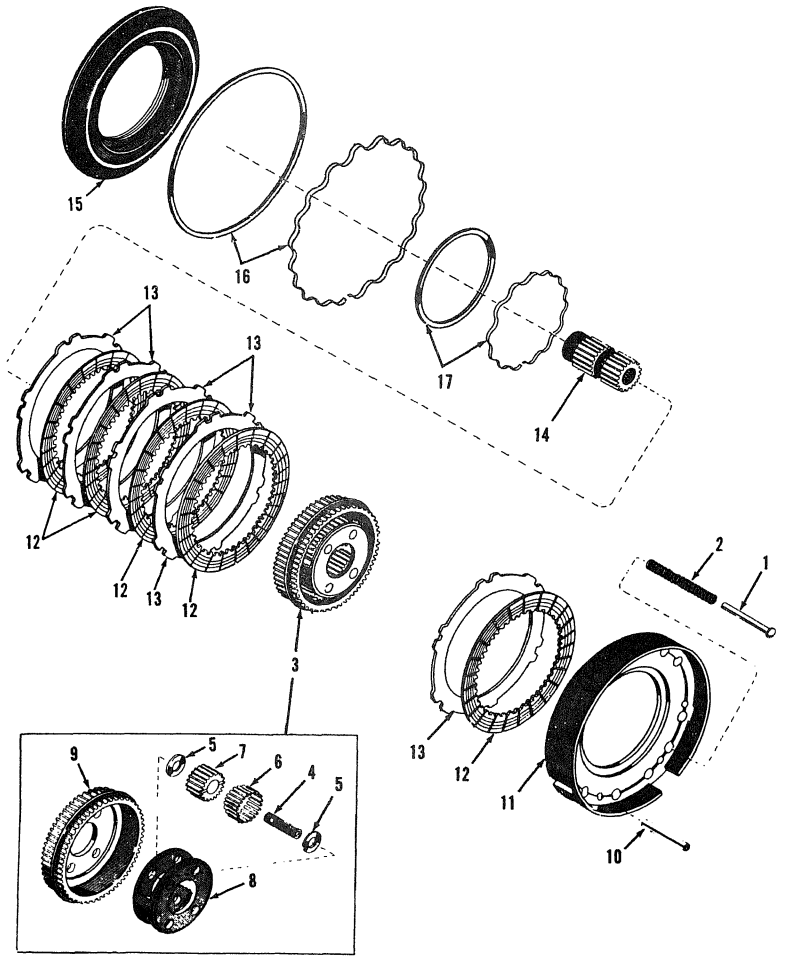
(*b*) Inspect bearings for wear and damage to races. Replace worn or damaged bearings.



1 Screw, cap, hex-head, 3/8-16 x 1-1/2 in. (10 rqr)
2 Housing
3 Plug
4 Piston
5 Seal and expander
6 Seal and expander
7 Clutch plate (4 rqr)
8 Clutch plate (4 rqr)
9 Forward ring gear
10 Thrust washer
11 Planetary carrier assembly
12 Pin (4 rqr)
13 Washer (4 rqr)
14 Roller (88 rqr)
15 Pinion (4 rqr)
16 Washer (4 rqr)
17 Planetary carrier
18 Thrust washer
19 Reverse ring gear
20 Retaining ring

MEC 3805-239-35/4-11

Figure 4-11. Forward clutch and planetary gear, exploded view.



MEC 3805-239-35/4-12

Figure 4–12. Reverse clutch and planetary gear, exploded view.

1 Spring pin (12)
2 Clutch return spring (12)
3 Planetary carrier assembly
4 Pin (4)
5 Thrust washer (8)
6 Rollers (88)
7 Pinion (4)
8 Carrier
9 Reverse clutch hub
10 Pin (6)
11 Anchor
12 Clutch plate (5)
13 Clutch plate (5)
14 Forward and reverse sun gear
15 Reverse clutch piston
16 Seal and expander
17 Seal and expander

Figure 4–12—Continued.

(*c*) Inspect bearing housings and shafts for wear and damage. If damage cannot be repaired with crocus cloth, replace defective part.

(8) Inspect sleeve bearings and thrust washers for wear, damage, and overheating. If bearing is out-of-round, deeply scored, or worn replace bearing. Replace damaged or worn thrust washers.

(9) Inspect oil seals for cuts and hardness. Replace unserviceable oil seals.

(10) Inspect gears as follows:

(*a*) Inspect teeth for scuffs, nicks, scoring, or broken teeth. Replace damaged gears.

(*b*) Inspect gears for wear to teeth that may have destroyed original shape. Replace gear if teeth are worn.

(*c*) Check thrust faces of gears for wear and damage. Replace gears if damage cannot be repaired.

(11) Inspect all splined parts for worn or damaged splines. Replace parts that cannot be repaired.

(12) Inspect springs for hardness, permanent set, and wear.

(13) Check all parts against dimensions and tolerances listed in the repair and replacement standards. Replace all parts not conforming to these standards.

e. Torque Converter Housing.

(1) *Disassembly.*

(*a*) Do not remove converter regulator valve (15, fig. 4–7), spring (14), and pin (13) unless replacement is necessary. The same applies to lube regulator valve (12). To replace valves pull or drive pins (10 and 13) from housing and remove springs and valves.

(*b*) Remove four screws (16) and remove ground sleeve (17) by tapping sleeve loose with a soft hammer.

(*c*) Remove retaining ring from outer race of bearing (20). Remove accessory driven gear (21) with bearings attached.

(*d*) Remove bearing (18), retaining ring (19) and bearing (20) from accessory drive gear.

(*e*) Do not remove sleeve bearing (22), plugs (23, 24, and 26), or dowel pins (25) from housing unless replacement is necessary.

(*f*) Slit diaphragm (10, fig. 4–5) with a sharp chisel or other suitable tool at approximately the 9 o'clock position. The slit should extend radially between the diaphragm inside diameter and outside diameter, staying in about 6 inch from either edge.

(*g*) Insert short edge of an "L" shaped bar in the chisel slit. Install a block under the bar and press down on the diaphragm outside diameter. The diaphragm will shrink and can be lifted out. Do not force tools between diaphragm and housing bore. Damage could result to housing bore. Remove oil seal (11, fig. 4–5).

(2) *Cleaning, inspection, and repair.* Refer to the instructions in *c* and *d* above for cleaning, inspection, and repair of the torque converter housing.

(3) *Reassembly.*

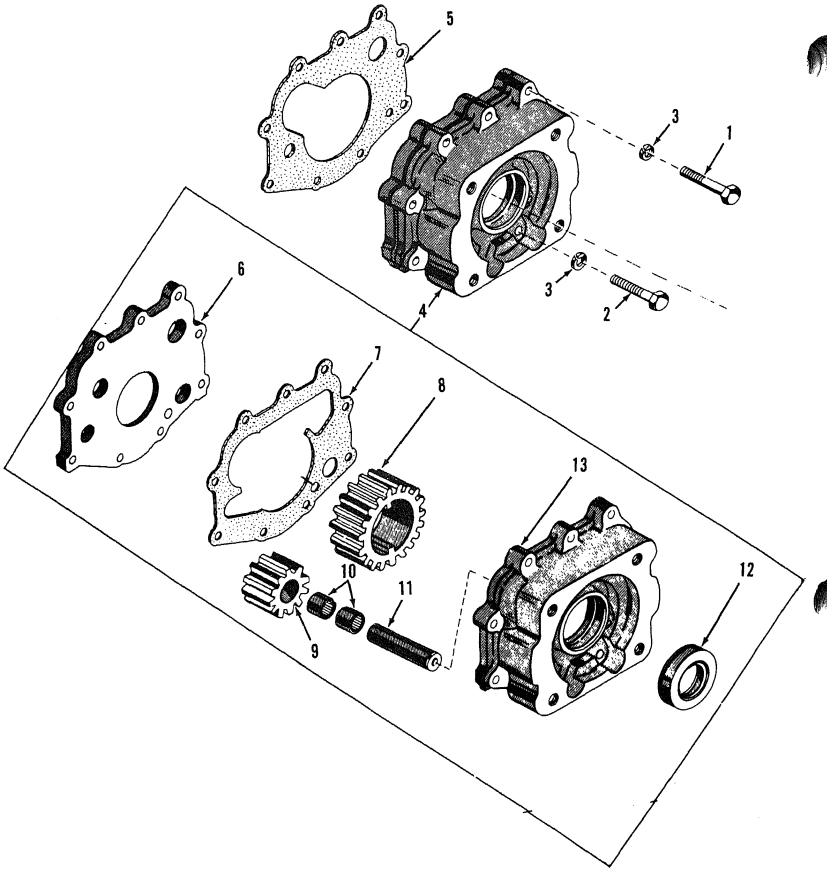
(*a*) If dowel pins (25, fig. 4–7) were removed install new dowel pins by pressing into place until end projects 0.0440 inch from surface.

(*b*) If sleeve bearing (22) was removed, heat bearing and install bearing by driving evenly into bore.

(*c*) Install bearing (20) on accessory driven gear (21). Install retaining ring (19) and bearing (18). Install gears and bearings in housing. Install retaining ring on outer race of bearing (20).

(*d*) Install ground sleeve (17) and aline holes. Secure sleeve with screws (16). Tighten screws to a torque of 17 to 20 pounds feet.

(*e*) If regulator valves (12 and 15) were removed, install valves and springs (11 and 14) in housing. Drive converter regulator



1 Screw, cap, hex-head, 3/8-16 x 2 in. (2 rqr)
2 Screw, cap, hex-head, 3/8-16 x 3 in. (2 rqr)
3 Washer, lock, 3/8 in. (9 rqr)
4 Oil pump assembly
5 Gasket
6 Cover
7 Gasket
8 Drive gear
9 Driven gear
10 Bearing (2 rqr)
11 Shaft
12 Oil seal
13 Body

MEC 3805-239-35/4-13

Figure 4–13. Transmission charging oil pump, exploded view.

valve pin (13) into housing until it projects 1.1900 inches from housing. Drive lube regulator valve pin (10) into housing until pin is flush to 0.0100 inch below surface of housing.

(*f*) Apply a light coating of Permatex around diaphragm seal bore and press new oil seal (11, fig. 4–5). Support diaphragm in seal area when installing oil seal. Remove excess Permatex.

(*g*) Clean diaphragm outside diameter and housing bore and coat housing bore edge with Permatex. Insert diaphragm into housing and press diaphragm into bore with hands as far as possible. Use a block of wood at least 2 inches wide to slowly tap diaphragm diameter until it is firmly seated. Remove excess Permatex.

f. Torque Converter.

(1) *Disassembly.*

(*a*) Drive nine pins (2, fig. 4–6) in until they clear support. Remove first turbine support (6).

(*b*) Remove second turbine (4). Do not remove bearing (3) unless replacement is necessary. Pull or drive bearing from turbine to remove.

(*c*) Do not remove bearing (1) from support (5) unless replacement is necessary. Pull or drive bearing from support to remove.

(*d*) Remove remaining 8 screws (7) and strips (8). Remove retainer (9), gasket (10), bearing (11) and gear (12). Remove oil seal (13) from gear.

(2) *Cleaning inspection, and repair.* Refer to instructions in *c* and *d* above for cleaning, inspection, and repair of the torque converter.

(3) *Reassembly.*

(*a*) Install new seal (13, fig. 4–6) in bore of gear (12). Install bearing (11) in gear and aline holes in gasket (10) with holes in gear. Install gear and bearing in pump (17). Bearing must be installed with loader notch toward front of transmission.

(*b*) Install retainer (9) and secure with screws (7) and lock strips (8). Bend lock strips over screw heads.

(*c*) If removed, press bearing (1) on support (5) and bearing (3) on second turbine (4).

(*d*) Install second turbine (4) into first turbine support (6). Install parts into first turbine support (5), with turbine flush to 0.0100 inch below surface of edge of support. -V grooves in turbine rim and support must be alined. Secure turbine to support with pins (2). Drive pins into support so that pins are flush to 0.0300 inch below outside diameter of support.

g. Transmission Housing and Output Shafts.

(1) *Disassembly.*

(*a*) Remove screw (20, fig. 4–3) and remove suction tube (21) by removing nut (22) and seal ring (23).

(*b*) Remove pipe plugs if necessary to replace plugs.

(*c*) Remove oil seal (9, fig. 4–2) from front of housing. Remove retaining ring (10) and remove shaft (12) and bearing (11). If bearing is to be replaced, drive bearing from shaft. Remove transfer driven gear (13).

(*d*) Remove second oil seal (9) from rear of housing. Remove retaining ring (10) and second bearing (11), if bearing is to be replaced.

(2) *Cleaning, inspection, and repair.* Refer to instructions in *c* and *d* above for cleaning, inspection, and repair of housing and shafts.

(3) *Reassembly.*

(*a*) If removed, install bearing (11, fig. 4–2) in housing. Install bearing (11), on shaft (12). Install transfer driven gear (13) and hold in place in housing.

(*b*) Install shaft through gear and bearing. Tap end of shaft with a soft hammer to seat shaft in bearing.

(*c*) Secure bearings with retaining rings (10). Install oil seals (9). Coat seals with grease (GAA) before installation.

(*d*) Install pipe plugs if removed.

(*e*) Install suction tube (21, fig. 4–3), nut (22) and seal ring (23). Secure tube with screw (20).

h. Turbine Driven Gears and Freewheel Unit.

(1) *Disassembly.*

(*a*) Press second turbine driven gear (14, fig. 4–8) out of first turbine driven gear (5).

(*b*) Bearing (1) and spacers (2 and 3) will come out at the same time. Rollers (9) will be loose and also fall out. Use care not to lose any rollers.

(*c*) Remove bearing (4) from first turbine driven gear (5).

(*d*) Remove nuts (7). Pry freewheel cam (10) from driven gear (14). Remove spring plate (11), roller cage (8), screws (6) and oil collector (13) from freewheel cam.

(*e*) Do not remove bearings (15 and 16) unless replacement is necessary. Drive or pull bearings from gear.

(2) *Cleaning, inspection, and repair.* Refer to instructions in *c* and *d* above for cleaning, inspection, and repair of the turbine driven gears and freewheel unit.

(3) *Reassembly.*

(*a*) Install bearings (15 and 16, fig. 4–8) on driven gear (14). Press bearings against shoulders on gear.

(*b*) Install oil collector (13) on freewheel cam (10). Install screws (6) through collector and cam, with screws seated against flat surface of collector.

(*c*) Place a rubber band around screws to hold them in place and position cam on bench with threaded end of screws facing up.

(*d*) Install roller cage (8) in cam. Grease pockets in cage lightly with grease (GAA). Install rollers (9) in cage and cam.

(*e*) Install assembled cage and cam on driven gear (5). Screw heads must be in place within lip on collector rim.

(*f*) Remove rubber band from screws. Install spring plate (11) and springs (12). Aline index marks on plate cam, and roller cage. Install driven gear (14) on freewheel cam and aline holes. Press driven gear (14) into driven gear (5) to seat bearing (5) into bore of driven gear (5).

(*g*) Check screws to see they are still in place and will not rotate. Install nuts (7) and tighten evenly to position driven gear (14) against spring plate.

(*h*) Turn assembly over and install spacer (3) on driven gear shaft. Press ball bearing (4) on gear shaft and into driven gear (5). Install spacer (2) and press bearing (1) on gear shaft.

i. Reverse Clutch and Planetary Gears.

(1) *Disassembly.*

(*a*) Do not remove seals and expanders (16 and 17, fig. 4–12) unless replacement is necessary. Pry seals and expanders from piston to remove.

(*b*) Disassemble planetary carrier assembly (3) only if there is evidence of wear or damage. If only one pinion requires replacement, all pinions must be replaced. Press four pins (4) from carrier (8). Remove thrust washers (5), pinions (7), and rollers (6).

(*c*) Remove hub (9) from carrier (8).

(*d*) Do not remove pins (10) from anchor (11) unless replacement is necessary. Drive pins from anchor to remove pins.

(2) *Cleaning, inspection, and repair.* Refer to instructions in *c* and *d* above to clean, inspect, and repair reverse clutch and planetary gear.

(3) *Reassembly.*

(*a*) Press pins (10, fig. 4–12) into anchor (11) if they were removed. Press in until reverse clutch end of pin extends 1.5500 inches from flat surface of anchor.

(*b*) If possible refrigerate pins (4) for one hour to cool pins. Fabricate an alining tool by grinding a pin (4) to 0.0050 inch undersize. Install a thrust washer (5) on alining tool.

(*c*) Coat bore of pinion (7) with grease (GAA) and install pinion on alining tool. Install rollers (6) into space between alining tool and pinion bore.

(*d*) Install second thrust washer (5) on alining tool. Remove alining tool and install pinion, rollers, and thrust washers in carrier (8) with chamfered end of bores in carrier up.

(*e*) Insert alining tool to center pinion assembly with bore in carrier. Repeat above steps to install the three remaining pinions.

(*f*) Place carrier and pinions in bore of hub (9). Line up pinion bores with bores in hub by using alining tool.

(*g*) Press chilled pins (4) through carrier, pinions, and hub. Press pins to dimension shown in the inset on figure 4–14.

(*h*) Stake both ends of pins with an octagon punch to secure pins. Check pinion rotation. Pinions must rotate freely after staking.

(*i*) If removed install seals and expanders (16 and 17, fig. 4–12) in grooves of piston (15).

j. Forward Clutch and Planetary.

(1) *Disassembly.*

(*a*) Remove retaining ring (20, fig. 4–11) from ring gear (19). Separate ring gear from planetary carrier assembly (11).

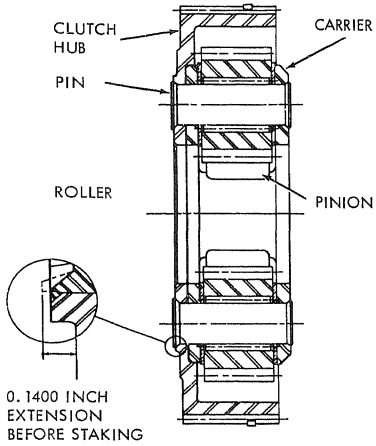


Figure 4–14. Reverse planetary carrier pin dimension.

(*b*) Disassemble carrier assembly only if there is evidence of wear or damage. If only one pinion requires replacement, all pinions must be replaced.

(*c*) Press four pins (12) from carrier (17). Remove pinions (15), rollers (14) and thrust washers (13 and 16) from carrier.

(*d*) Remove piston (4) from housing (2).

(*e*) Do not remove seals and expanders (5 and 6) from piston unless replacement is necessary. Pry out seals and expanders to remove.

(2) *Cleaning, inspection, and repair.* Refer to instructions in *c* and *d* above to clean, inspect, and repair the forward clutch and planetary gear.

(3) *Reassembly.*

(*a*) If seals and expanders (5 and 6, fig. 4–11) were removed install new seals and expanders in piston (4).

(*b*) If possible, refrigerate four pins (12) for one hour.

(*c*) Fabricate a alining tool by grinding a pin (12) 0.0050 inch undersize.

(*d*) Install thrust washer (13) on alining tool. Coat bore of pinion (15) with grease (GAA) and install pinion on alining tool. Install rollers (14) between alining tool and pinion. Install thrust washer (16) on alining tool.

(*e*) Remove alining tool and install pinion assembly in carrier (17). Install alining tool through carrier and pinion assembly to aline with bore of carrier. Place carrier assembly in a press and press pin (12) through carrier and pinion. Press pin to dimension shown on figure 4–15.

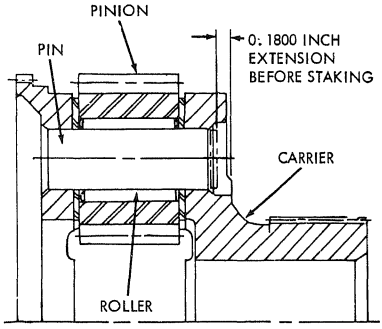


Figure 4–15. Forward planetary pin dimension.

(*f*) Stake both ends of pin with an octagon punch. Check pinion rotation. Pinion must rotate freely after staking. Install remaining three pinions in the same manner.

(*g*) Install ring gear (19, fig. 4–11) on carrier assembly (11) and secure with retaining ring (20).

k. Direct Drive Clutch.

(1) *Disassembly.*

(*a*) Do not remove bearing (17, fig. 4–10) or pins (15) from drive gear (16) unless replacement is necessary. Pull bearing from gear and drive out pins to remove.

(*b*) Do not remove retaining ring (13) or bearing (11) from clutch hub (12) unless they are to be replaced. Remove bearing and ring from hub.

(*c*) Remove retaining ring (8) from

hub of piston housing (3). Remove return spring (7). Remove packing (6).

(*d*) Remove piston (5) from housing. Do not remove seal and expander (4) from housing unless replacement is necessary. Pry seal and expander from housing to remove.

(*e*) Do not remove bearing (18) from housing unless replacement is necessary. Pull bearing from housing to remove.

(*f*) Do not remove packing (19) from housing unless replacement is necessary. Remove packing.

(2) *Cleaning, inspection, and repair.* Refer to instructions in *c* and *d* above to clean, inspect, and repair direct drive clutch.

(3) *Reassembly.*

(*a*) Install packing (19, fig. 4–10) in housing (3). Install bearing (18) on housing.

(*b*) Install seal and expander (4) in groove of piston (5). Install piston in housing (3).

(*c*) Install packing (6) and return spring (7), with concave side toward piston. Install retaining ring (8). Depress spring to install ring.

(*d*) Install bearing (11) and retaining ring (13) on clutch hub (12).

(*e*) If pins (15) were removed from gear (16), install pins in gear. Press pins into gear so that end of pin facing clutch plate extends 0.7500 inch from surface of gear.

(*f*) Install bearing (17) on gear (16).

l. Oil Pump.

(1) *Disassembly.*

(*a*) Tap pump body (13, fig. 4–13) to loosen pump cover (6). Remove cover and gasket (5).

(*b*) Remove drive gear (8). Remove driven gear assembly (9 and 10). Do not remove roller bearings from gear unless replacement is necessary. Press bearings from gear to remove.

(*c*) Do not remove shaft (11) unless replacement is necessary. Press shaft from body to remove.

(*d*) Do not remove oil seal (12) from body unless replacement is necessary. Press seal from body to remove.

(2) *Cleaning, inspection, and repair.* Refer to instructions in *c* and *d* above to clean, inspect, and repair the oil pump.

(3) *Reassembly.*

(*a*) Press a new oil seal (12, fig. 4–13) into body (13) if it was removed.

(*b*) If shaft (11) was removed, press shaft into body until shaft extends 0.0480 inch above cover split line of body.

(*c*) If bearings (10) were removed, press new bearings into gear (9). Ends of bearings must be 0.0600 inch below face of gear. Install bearings by placing driver against numbered end of bearing cage. Install gear assembly on shaft (11).

(*d*) Install drive gear (8). Install cover (6) and gasket (7) on body. Aline holes in cover, gasket and body.

m. Control Valve.

(1) *Disassembly.*

(*a*) Remove plug (6, fig. 4–4), gasket (7), one spring (8) and detent ball (9).

(*b*) Remove plug (10) and gasket (11).

(*c*) Remove valve stop (13) from selector valve (15). Remove selector valve (13) by tapping on plug end of valve. Drive oil seal (14) from body with selector valve.

(*d*) Remove second detent ball (9) and spring (8).

(*e*) Remove cutoff valve plug (17) and gasket (18). Remove plug (19), packing (20) and cup (21) from plug.

(*f*) Remove clutch cutoff valve (22) and valve spring (23).

(*g*) Remove plug (24), gasket (25), and regulator valve (26).

(*h*) Remove plug (27), gasket (28), plug (29), springs (30 and 31), and spring retainer (32).

(*i*) Do not remove orifice plug (35), ball (34) or ball retainer plug (33) unless replacement is necessary.

(2) *Cleaning, inspection, and repair.* Refer to instructions in *c* and *d* above to clean, inspect, and repair the transmission control valve.

(3) *Reassembly.*

(*a*) If orifice plug (35, fig. 4–4), was removed, press plug into body until plug is flush to 0.0100 inch below surface. If orifice ball (34) and plug (33) were removed, install ball and press plug into body until plug is flush to 0.0100 inch below surface.

(*b*) Install spring retainer (32) on one end of spring (31) and install retainer, inner spring, and outer spring (30).

(*c*) Install plug (29), gasket (28), and plug (27) behind springs in body. Tighten plug securely.

(*d*) Install regulator valve (26) with small end of valve properly seated in spring retainer (32). Install plug (24) and gasket (25) tighten plug securely.

(*e*) Install valve spring (23) and clutch cutoff valve (22). Install packing (20) on plug (19). Install plug (19) and cup (21) into cutoff valve plug (17).

(*f*) Install plug (17) and gasket (18). Tighten plug securely. Install plug (16) into plug (17).

(*g*) Install one detent spring (8) and one detent ball (9). Depress ball against spring and install selector valve (15), engaging ball in detent slot.

(*h*) Install ball (9), spring (8), gasket (7) and plug (6). Tighten plug securely.

(*i*) Install new oil seal (14). Press oil seal into body flush to 0.0300 inch below surface.

n. Reassembly of Transmission.

(1) Position the main transmission housing (26, fig. 4–3) on blocks on the rear side. Install reverse clutch piston (15, fig. 4–12) and seal and expanders (16 and 17). Coat outside diameter of seals with petroleum jelly before installation.

(2) Dip internally splined clutch plates (12) in engine oil (OE) and install five clutch plates (13) and four plates (12) in transmission. Install planetary carrier assembly (3) and the remaining internally splined clutch plate (12) on the positioning ring.

(3) Install anchor (11). Aline slot in anchor with anchor pin. Pins (10) in anchor should be indexed with slotted tangs of external clutch plates (13).

(4) Starting with an internal splined clutch plate (8, fig. 4–11) alternately install two clutch plates (8) and two clutch plates (7).

(5) Install planetary carrier (11) and reverse ring gear (19). Install forward ring gear (9).

(6) Install remaining clutch plates (7 and 8). Install springs (2, fig. 4–12) and pins (1). Correct springs are painted green on one end.

(7) Install piston (4, fig. 4–11) and housing (2). Press on housing to compress springs and install two screws (1), 180° apart, through housing. Install remaining eight screws and pull housing down evenly. One screw hole is out of line with other nine so that housing cannot be installed incorrectly.

(8) Install transfer drive gear (16, fig. 4–10) and ball bearing on forward planetary carrier. Install retaining ring (14) to secure gear.

(9) Install clutch hub (12), bearing (11), and retaining ring (13).

(10) Install two clutch plates (9) and one clutch plate (10).

(11) Install piston housing (3) and piston (5). Install screws (1) and lock tabs (2). Bend lock tabs to secure screws .

(12) Install gasket (15, fig. 4–3), seal ring (14) and cover (13). Aline clutch oil apply line in cover with oil apply line in housing. Install screws (11) and lock washers (12) to secure cover.

(13) Turn transmission over to bring torque converter side to the top.

(14) Install accessory drive shaft (1, fig. 4–9) and bearing (2).

(15) Install first turbine drive gear (31, fig. 4–7) and packing (27). Install roller bearing (29) and thrust races (28 and 30).

(16) Install forward and reverse sun gear (14, fig. 4–12).

(17) Install second turbine driven gear (14, fig. 4–8), first turbine driven gear (5) and freewheel unit as an assembly.

(18) Install second turbine drive gear (9, fig. 4–7), packing (7), bearing (8), and retaining ring (6).

(19) Install converter housing gasket (25, fig. 4–3) and aline holes in gasket with holes in housing.

(20) Attach a suitable sling to the engine mounting face of the converter housing (5, fig. 4–7) and use a hoist to lower housing on transmission housing. Install 23 screws (4), screw (1), 24 lock washers (2) and flat washers (3) and tighten screws securely.

(21) Install torque converter pump (19, fig. 4–6) with attached parts in housing. Install spacer (16) on ground sleeve splines. Install converter stator (15) on ground sleeve. Secure stator with retaining ring (14).

(22) Install first and second turbine assemblies as a unit engaging the splines in the tur-

bines with splines on first turbine drive gear (31, fig. 4–7) and splines on second turbine drive gear (9).

(23) Check that packing (9, fig. 4–5) is in place on converter pump. Install pump cover (7) and ball bearing on converter pump. Secure cover with nuts (6). Tighten nuts securely.

(24) Install disk assembly (5) and three flexible disks (4). Install plate (3) and secure with screws (2). Tighten screws securely.

(25) Use a suitable hoist and stand transmission upright. Install control valve (4, fig. 4–4) and new gasket (5) on transmission and secure with screws (1 and 2) and washers (3). Tighten screws securely.

(26) Refer to TM 5–3805–239–12 and install parking brake.

(27) Coat splines of front output shaft (12, fig. 4–2) and lip of oil seals (9) with grease (GAA).

(28) Heat front output flange (3) to a minimum of 250° F. Install flange on shaft until flange is tight against shoulder on shaft. Install washer (2) and nut (1) and tighten nut to a torque 600 to 800 foot-pounds.

(29) Install rear output flange (7), washer (6) and nut (5) in same manner.

(30) Fill the oil pump (4, fig. 4–13) with engine oil (OE) and install oil pump and gasket (5) on transmission. Secure pump with screws (1 and 2) and lock washers (3).

(31) Install strainer (3, fig. 4–3) and gasket (4) and secure with screws (1) and lock washers (2).

(32) Install cover (8) and gasket (9) and secure with screws (6) and lock washers (7).

(33) Install breather (5) and drain plug (10).

o. Installation. Refer to paragraph 2–31 and install the transmission. Refer to TM 5–3805–239–12 and fill the transmission with oil.

CHAPTER 5
HYDRAULIC SYSTEM REPAIR INSTRUCTIONS

Section I. GENERAL

5–1. Description

a. The hydraulic system of the loader provides the power to raise and lower the boom, open and close the bucket, and operate the bucket clam.

b. Main components of the system are the tandem hydraulic pump, a three spool control valve, and the hydraulic cylinders which provide the actual movement. Three sets of cylinders are part of the system. Two cylinders actuate the boom, two actuate the bucket to open and close it, and the clam is operated by the two cylinders mounted on the rear of the bucket. Figures 5–1 and 5–2 illustrate the hydraulic system.

c. The hydraulic system covered in this chapter applies only to the boom and bucket operation. Power steering hydraulics will be included in the power steering chapter.

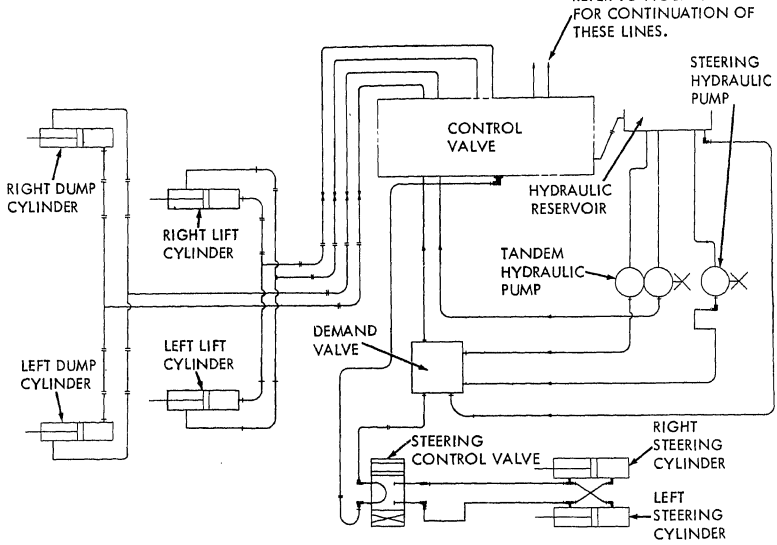
5–2. Operation

a. General. In the following paragraphs the components and operation of the hydraulic system will be described.

b. Hydraulic Pump. The hydraulic pump (fig. 5–1) is mounted on the transmission housing and is driven by the engine crankshaft through a gear train. The pump is in operation whenever the engine is running. Output of the pump varies with the speed of the engine. Oil is drawn from the hydraulic reservoir (fig. 5–1), through a strainer and magnet, to the pump. At low engine speed, a portion of the pump output is diverted by the demand valve (fig. 5–1) to the power steering system to provide enough power for steering at low engine speed. When not required to operate the boom and bucket the oil flows through the control valve (fig. 5–1) and returns to the reservoir. The pump is a tandem pump, having two working units, to properly supply the hydraulic system.

c. Control Valve. The hydraulic control valve (fig. 5–1) is mounted on the right hand side of the loader next to the hydraulic reservoir. Control levers, connected to the valve plungers through linkages, operate the valve. Movement of the levers moves the plungers and allows oil to flow from the valve to the appropriate cylinder. A pressure relief valve (fig. 5–1), mounted in the control valve, regulates the pressure in the hydraulic system. When pressure exceeds 1800 psi oil is bypassed from the valve directly to the reservoir. Overload relief valves protect the hydraulic circuits when controls are in neutral. Check valves allow oil to be transferred between ends of the hydraulic cylinders to keep cylinders supplied with oil.

d. Hydraulic Reservoir. The hydraulic reservoir (fig. 5–1) is mounted behind the driver. Oil is stored in the reservoir and is drawn from the reservoir by the pump for use in the system. An oil filter and outlet strainer and magnet are installed in the reservoir. A combination vacuum-pressure relief valve is also contained in the reservoir. The valve relieves internal pressure within the reservoir and also permits the inlet of filtered air to prevent a vacuum from forming in the system.



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Figure 5–1. Loader hydraulic system, schematic view.

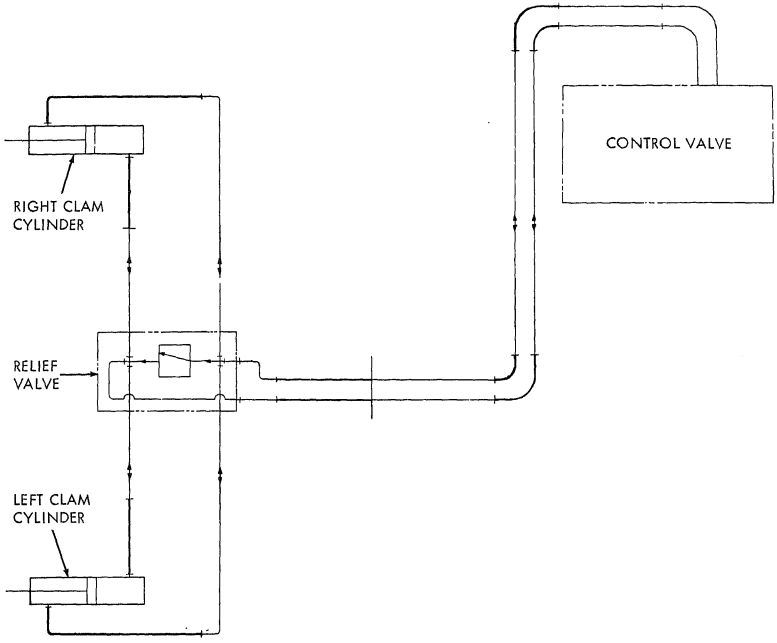


Figure 5–2. Bucket hydraulic system, schematic view.

Section II. HYDRAULIC PUMP

5–3. General

The gear-type fixed displacement tandem pump is driven by the transmission through a splined shaft. Hydraulic lines from the pump carry oil to the pump from the reservoir and from the pump to the control valve, demand valve, and relief valve.

5–4. Hydraulic Pump

a. Removal. Refer to TM 5–3805–239–12 and remove the hydraulic pump.

b. Disassembly. Disassemble hydraulic pump in the numerical sequence as illustrated on figure 5–3 and the following instructions.

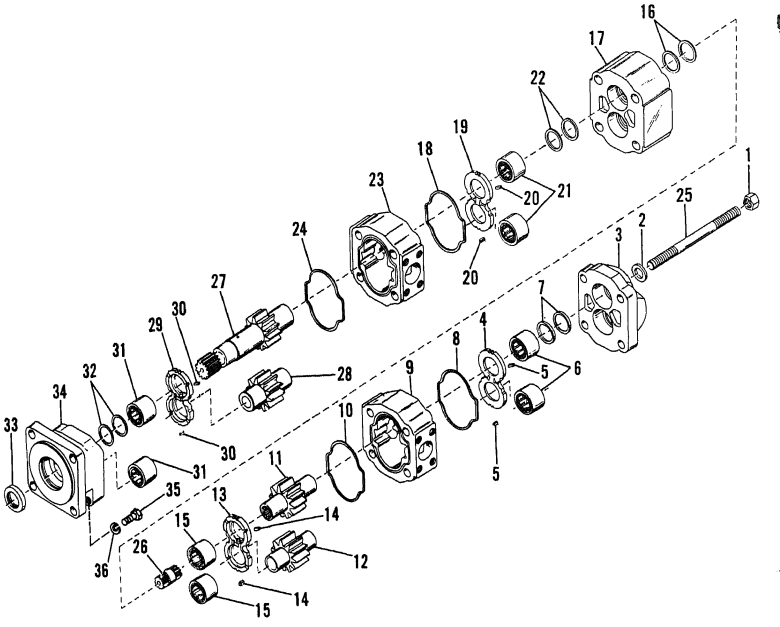
(1) Scribe a line lengthwise along the pump to aid in alinement at reassembly.

(2) If roller bearings (6, 15, 21, and 31) require replacement, remove the bearings, using a suitable bearing puller.

(3) Remove seal rings from bearing bores.

(4) Remove oil seal (33) from shaft end cover (34) using a suitable removing tool.

(5) Discard all seal rings, preformed packings, and oil seals.



MEC 3805-239-35/5-3

1 Nut, 5/16–18 (4)
2 Washer, flat, 5/16 in. (4)
3 Port end cover
4 Wear plate
5 Pocket seal (6)
6 Roller bearings (2)
7 Preformed packing (2)
8 Seal ring
9 Gear housing
10 Seal ring
11 Drive gear
12 Driven gear
13 Wear plate
14 Pocket seal (6)
15 Roller bearing (2)
16 Preformed packing (2)
17 Bearing carrier
18 Seal ring
19 Wear plate
20 Pocket seal (6)
21 Roller bearing (2)
22 Preformed packing (2)
23 Gear housing
24 Seal ring
25 Stud (4)
26 Drive shaft
27 Shaft and gear
28 Driven gear
29 Wear plate
30 Pocket seal (6)
31 Roller bearing (2)
32 Preformed packing (2)
33 Oil seal
34 Shaft end cover
35 Screw cap, hex-head, ½–13 x 1½ in. (4)
36 Washer, lock, ½ in. (4)

Figure 5–3. Hydraulic pump, exploded view.

. *Cleaning.* Clean all metal parts with ıning compound, solvent (Spec. P–S–661) dry thoroughly with compressed air.

***Warning:* The solvent is highly inflamble. Do not use solvent near an open flame.**

. *Inspection and Repair.*

(1) Inspect edges of gear teeth and gear faces for burs, scoring, and wear. Remove s with a fine stone. Replace gears if worn or ly scored.

Note. Gears (11 and 12) and gears (27 and 28) t be replaced as sets.

(2) Inspect shafts of gears for wear and ring. Replace gears if shafts are rough or naged or wear at bearing surfaces exceeds inal shaft diameter by 0.0010 inch. Replace rs if shafts are damaged in the seal area.

(3) Inspect roller bearings for free roll- pitting, and wear. Replace damaged bear- s.

(4) Inspect gear housings for wear and nage. Replace worn or damaged housings. pect mating surfaces of gear housings, ring carrier, and end covers for burs and nage. Remove burs with a fine file or stone possible. Replace part if surface is badly naged.

(5) Inspect wear plates for wear and ring. Replace plates if badly worn or scored.

(6) Check all parts against tolerances ed in table 1–1. Replace all parts not con- ming to repair and replacement standards.

. *Reassembly.* Reassemble the hydraulic np in reverse of the numerical sequence as strated on figure 5–2 and the following in- uctions.

(1) Coat all preformed packings, pocket ls, and seal rings with grease (GAA) before tallation.

(2) Press oil seal (33) into shaft and er (34) with lip face of seal facing toward ide of bore.

(3) Install shaft end cover in a vise with jaws. Install packings and roller bearings end cover.

(4) Grease pocket seals (30) with grease AA) and install in two middle slots of wear te (29). Install wear plate, with pocket seal s toward face of shaft end cover, on shaft cover and tap wear plate in place. Leave rance of 1/32 (0.03125) inch between wear te and end cover.

(5) Install four outer pocket seals (5) in wear plate (4). Push seals into slots until end of seals contact bearing races. Tap wear plate solidly into position on end cover (3). Use a razor blade or sharp knife to trim exposed ends of pocket seals so they are flush with sides of wear plate.

(6) Install gear housing (23) in a vise with soft jaws and install wear plate (19) in the same manner as described above.

(7) Install port end cover (3) in a vise with soft jaws and install packings (7), bearings (6), and wear plate (4).

(8) Install bearing carrier (17) in a vise with soft jaws and install packings (16 and 22), bearings (21) and wear plate (19).

(9) Install assembled shaft end cover (34) in a vise with soft jaws. Coat wear plate with engine oil (OE). Install shaft with gear (27) and driven gear (28) in shaft end cover.

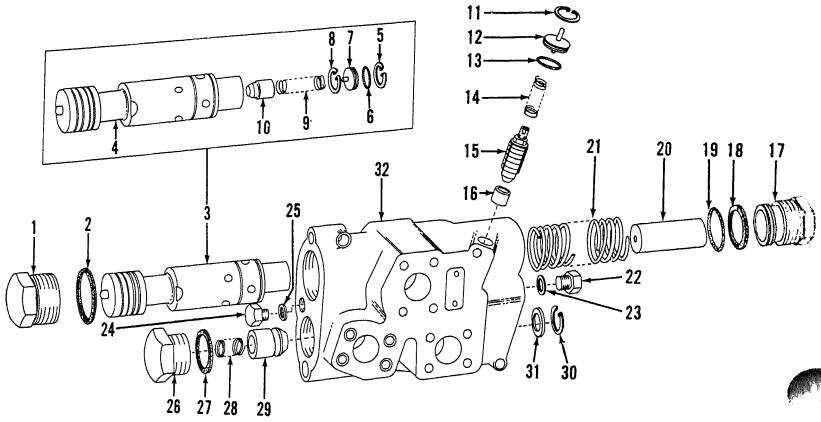
(10) Install seal rings (24 and 18) in grooves in gear housing (23) and install gear housing over gears on shaft end cover. Tap gear housing with a leather hammer to seat housing on cover. Oil gears with engine oil (OE) to provide initial lubrication.

(11) Install drive shaft (26) in bore of shaft with gear (27). Install bearing carrier (17) on gear housing, with scribe marks alined. Tap bearing carrier in place.

(12) Install drive gear (11) on drive shaft (26) and install driven gear (12) in bore of bearing carrier. Install seal rings (10 and 8) in grooves in gear housing (9). Install gear housing over gears and tap into place. Oil gears with engine oil (OE) to provide initial lubrication.

(13) Install port end cover (3) on gear housing and tap into place. Install four studs (25) through port end cover and thread into shaft end cover, until end of studs extend above port end cover far enough to install washers (2) and nuts (1). Tighten nuts to a snug fit.

(14) Rotate pump drive shaft (27) and check for ease of rotation. Shaft should turn when using a six inch wrench. If shaft rotates freely, tighten nuts to a torque of 200 foot-pounds. Rotate shaft again to check freedom of rotation. Pump should rotate freely, with no evidence of binding. If binding is evident, disassemble pump and check cause of binding.



1 Plug
2 Gasket
3 Check valve assembly
4 Check valve
5 Ring, retaining
6 Preformed packing
7 Plug
8 Ring, retaining
9 Spring
10 Plug
11 Ring, retaining
12 Plug
13 Preformed packing
14 Spring
15 Relief valve
16 Relief valve seat
17 Plug
18 Gasket
19 Preformed packing
20 Plug
21 Spring
22 Plug
23 Gasket
24 Plug
25 Gasket
26 Plug
27 Gasket
28 Spring
29 Check valve
30 Ring, retaining
31 Ring, orificed
32 Demand valve body

MEC 3805-239-35/5-4

Figure 5-4. Hydraulic demand valve, exploded view.

5–5. General

a. When the engine is operating at speeds below 1500 rpm the output of the power steering hydraulic pump is insufficient for the requirements of the power steering system. The hydraulic demand valve (fig. 5–1) diverts a portion of the hydraulic pump output to the steering system to provide power for smooth steering.

b. The demand valve is mounted below the hydraulic reservoir on the left side of the vehicle.

5–6. Hydraulic Demand Valve

a. Removal. Refer to paragraph 2–35 and remove the hydraulic demand valve.

b. Disassembly. Disassemble the hydraulic demand valve in the numerical sequence as illustrated on figure 5–4. Discard all preformed packings.

Note. Do not disassemble relief valve (15).

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

d. Inspection and Repair.

(1) Inspect relief valve for scratches and damage. Replace parts if defective. Both parts must be replaced as an assembly.

(2) Inspect sealing surfaces of check valve plunger for scratches and damage. Replace plunger if scratched or damaged.

(3) Inspect springs for weak or broken condition. Replace all defective springs.

(4) Check all parts against tolerances listed in table 1–1. Replace all parts not conforming to repair and replacement standards.

(5) Replace all damaged, worn, or defective parts.

e. Reassembly. Reassemble the demand valve in reverse of the numerical sequence as illustrated on figure 5–4.

f. Installation. Refer to paragrapn 2–35 and install the demand valve.

Section IV. HYDRAULIC CYLINDERS

5–7. General

a. The boom and bucket are operated under hydraulic power, with cylinders providing the motive force. Two cylinders power the boom lift and lower operation. A pair of cylinders mounted on the boom open and close the bucket during operation. The two cylinders mounted on the rear corners of the bucket operate the clam.

b. Hydraulic oil pressure from the control valve enters the cylinders and moves the piston action. As the piston moves, it moves the boom, in either direction, depending upon the valve bucket, or clam linkage, performing the operation the operator has directed. The cylinders are very similar, being totally different only in length or in the placement of the indicators on the cylinder.

5–8. Hydraulic Cylinders

a. Removal. Refer to TM 5–3805–239–12 and remove the hydraulic cylinders from the loader.

b. Disassembly.

(1) Refer to figure 5–5 and remove the bucket position indicator from the dump cylinder.

(2) Disassemble the dump cylinder in the numerical sequence as illustrated on figure 5–6. Discard all packings.

(3) Disassemble the lift cylinder in the numerical sequence as illustrated on figure 5–7. Discard all packings.

(4) Disassemble the clam cylinders in the numerical sequence as illustrated on figure 5–8. Discard all packings.

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

Warning: **The solvent is highly inflammable. Do not use solvent near an open flame.**

d. Inspection and Repair.

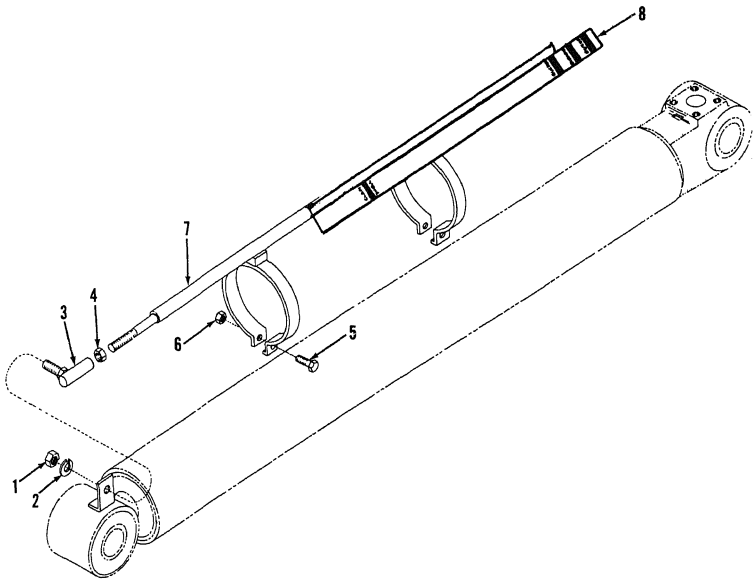
(1) Inspect all parts for wear, scoring, nicks, and damage.

(2) Replace all defective parts.

e. Reassembly. Reassemble the cylinders in reverse of the numerical sequence as illustrated on figures 5–5 through 5–8 and the following instructions.

(1) Install oil seals in end plates with lip of seal facing away from cylinder head.

(2) Lubricate locking nut, before installing on piston rod, with engine oil (OE) and



1 Nut, 1/2-20
2 Washer, lock, 1/2 in.
3 Ball joint
4 Nut, 1/2-13
5 Screw, cap, hex-head, 3/8-16 x 1-1/2 in. (2 rqr)
6 Nut, 3/8-16 (2 rqr)
7 Tube assembly
8 Position indicator

MEC 3805-239-35/5-5

Figure 5–5. Bucket position indicator, removal and installation.

tighten nut to a troque of 1400 to 1500 foot-pounds.

(3) Lubricate threads of cylinder head with engine oil (OE) and tighten head to a torque of 1400 to 1500 foot-pounds.

(4) When assembling lift cylinder, place V of piston packing (20, fig. 4–7) toward rear of cylinder.

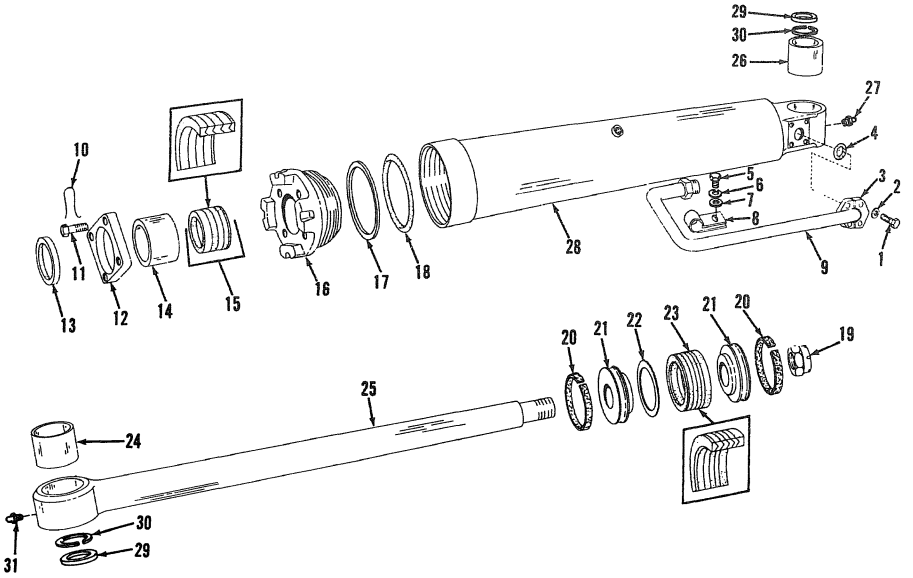
(5) When assembling dump cylinder, place V of piston packing (23, fig. 4–6) toward head end of cylinder.

(6) Install rod packing with V of packing toward rear of cylinder. Stagger ring gaps so no two gaps are adjacent and edges are not overlapped or doubled back.

(7) When installing end plates, tighten

screws alternately and evenly, using slight pressure on a short wrench. Do not overtighten. Lock screws with locking wire.

f. Installation. Refer to TM 5-3805-239-12 and install the hydraulic cylinders on the loader.

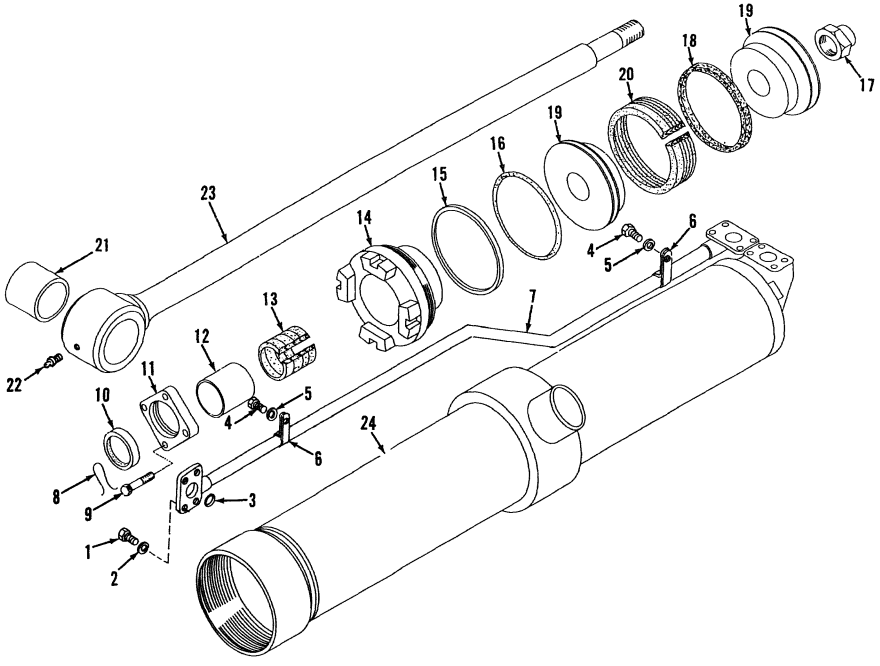


MEC 3805-239-35/5-6

Figure 5-6. Dump cylinder assembly, exploded view.

1 Screw, cap,, hex-head, ⅜–16 x 1¼ in. (4)
2 Washer, lock, ⅜ in. (4)
3 Flange, split (2)
4 Preformed packing
5 Screw, cap, hex-head, ⅜–24 x ¾ in.
6 Washer, lock, ⅜ in.
7 Washer, flat, ⅜ in.
8 Clamp
9 Tube assembly
10 Lock wire
11 Screw, cap, hex-head, ⅜–16 x 1½ in.
12 End plate
13 Oil seal
14 Sleeve bearing
15 Rod packing
16 Cylinder head
17 Back-up ring
18 Preformed packing
19 Nut, locking, 1¾
20 Bearing ring (2)
21 Piston (2)
22 Shim, 0.0359 thk (as rqr)
23 Piston packing
24 Sleeve bearing
25 Piston rod
26 Sleeve bearing
27 Lubrication fitting, 90°, ⅛ NPT
28 Tube assembly
29 Oil seal (4)
30 Retaining ring (4)
31 Lubrication fitting, straight, ⅛ NPT

Figure 5–6—Continued.

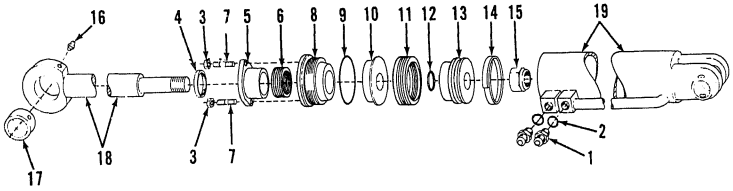


MEC 3805-239-35/5-7

Figure 5–7. I[illegible]ylinder, exploded view.

1 Screw, cap, hex-head, ⅜–16 x 1¼ in. (4)
2 Washer, lock, ⅜ in. (4)
3 Preformed packing
4 Screw, cap, hex-head, ⅜–24 x 1 in. (2)
5 Washer, lock, ⅜ in. (2)
6 Clamp (2)
7 Tube assembly
8 Lock wire
9 Screw, cap, hex-head, ⅜–16 x 1½ in. (4)
10 Oil seal
11 End plate
12 Sleeve bearing
13 Rod packing
14 Cylinder heao
15 Back-up ring
16 Preformed packing
17 Nut, locking, 1¾
18 Bearing ring (2)
19 Piston (2)
20 Piston packing
21 Sleeve bearing
22 Lubrication fitting
23 Piston rod
24 Cylinder tube

Figure 5–7—Continued.



1 Adapter (2 rqr)
2 Preformed packing (2 rqr)
3 Nut, self-locking, 3/8-24 (2 rqr)
4 Oil seal
5 Packing flange
6 Rod packing
7 Stud (2 rqr)
8 Cylinder head
9 Preformed packing
10 Piston
11 Piston packing
12 Preformed packing
13 Piston half
14 Wear ring, piston
15 Nut, 1-1/4-12
16 Lubrication fitting, straight, 1/8 NPT
17 Sleeve bearing
18 Piston rod
19 Cylinder tube

MEC 3805-239-35/5-8

Figure 5–8. Clam cylinder, exploded view.

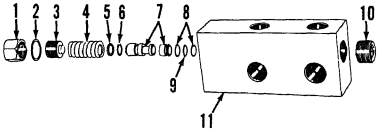
5–9. General

A safety valve, mounted in the center rear of the bucket, receives the oil from the hydraulic system and sends it to the two cylinders. If the clam is open and strikes an object and cannot move, pressure will build up in the top of the cylinders. To relieve this pressure the safety valve will open at 2150 to 2250 psi. When the valve opens, oil is bypassed from the top of the cylinders to the bottom, closing the clam.

5–10. Clam Safety Valve

a. Removal. Refer to TM 5–3805–239–12 and remove the safety valve from the bucket.

b. Disassembly. Disassemble the safety valve in the numerical sequence as illustrated on figure 5–9. Discard all packing and backup rings.



1 Relief valve cap
2 Cap gasket
3 Adjustment screw
4 Valve spring
5 Backup ring
6 Preformed packing
7 Plunger and seat
8 Backup ring (2 rqr)
9 Preformed packing
10 Pipe plug
11 Valve body

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Figure 5–9. Clam safety valve, exploded view.

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

***Warning:* The solvent is highly inflammable. Do not use solvent near an open flame.**

d. Inspection and Repair.

(1) Inspect all parts for wear, scoring, nicks, and damage.

(2) Replace all defective parts.

e. Reassembly. Reassemble the safety valve in reverse of the numerical sequence as illustrated on figure 5–9.

f. Installation. Refer to TM 5–3805–239–12 and install the clam safety valve on the bucket.

g. Testing.

(1) Disconnect top hose from cylinder.

Note. New safety valves are pre-set and require no adjustment. Repair or replacement valves should be checked and adjusted after installation.

(2) Install a tee fitting adapter in the cylinder and connect the hose to the tee.

(3) Install a pressure gage of at least 3000 psi capacity in the tee.

(4) Operate the loader (TM 5–3805–239–12) and open clam to bulldoze position. Drive loader until clam is against a stone wall or other immovable object.

(5) Attempt to push or bulldoze the object until the clam closes. Check gage to read pressure as clam is closing.

(6) If pressure gage does not read between 2150 and 2250 psi as clam is closing, adjust valve as follows.

(*a*) Remove valve cap (1, fig. 5–9).

(*b*) Turn adjusting screw (3) in to raise the pressure.

(*c*) Turn adjusting screw out to lower the pressure.

(*d*) Install valve cap after adjusting.

(7) Repeat test ((4) and (5) above) and check gage. Adjust valve until correct pressure (2150 to 2250 psi) is obtained.

(8) Remove gage and tee from cylinder and connect hose in normal position.

Section VI. HYDRAULIC RESERVOIR

1. General

. The hydraulic reservoir is mounted at the nt of the engine compartment beneath the cleaner shield. A cover at the top of the eld protects the components of the reser-r.

. Hoses and tubes leading from the reser-r carry the hydraulic oil to the tandem hy-ulic pump, the power steering pump, and demand valve. Return lines from the con-l valve carry the oil back to the reservoir.

2. Hydraulic Reservoir and Components

. *Removal.* Refer to TM 5–3805–239–12 and ıove the hydraulic reservoir and compo-ts.

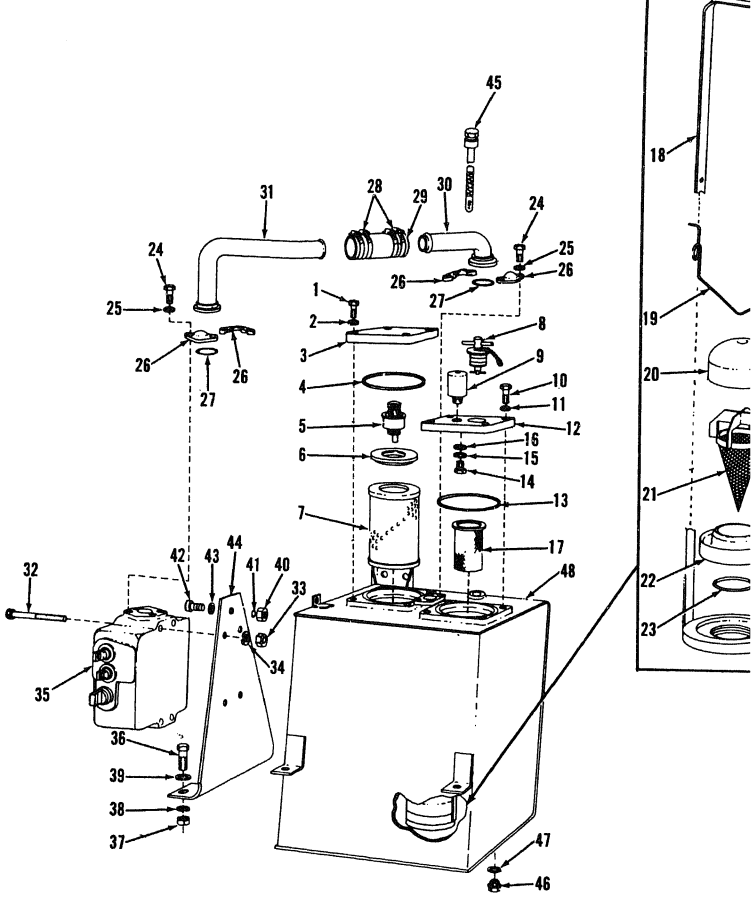
b. Cleaning. Refer to TM 5–3805–239–12 for information on cleaning the reservoir, strainer, and filters.

c. Inspection and Repair.

(1) Inspect reservoir (48, fig. 5–10) for cracks, evidence of leakage, and damage. Repair reservoir by welding, if possible. Replace reservoir if unserviceable.

(2) Inspect hoses (29) and tubes (30 and 31) for evidence of deterioration or damage. Replace damaged parts. Replace packings (27).

d. Installation. Refer to TM 5–3805–239–12 and install the reservoir and fill the hydraulic system.



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Figure 5–10. Hydraulic reservoir and control valve, exploded view.

1 Screw, cap, hex-head, ⅜–24 x 1½ in. (4)
2 Washer, lock, ⅜ in. (4)
3 Filter cover
4 Preformed packing
5 Bypass valve
6 Valve plate
7 Filter element
8 Filler plug
9 Vacuum pressure relief valve
10 Screw, cap, hex-head, ⅜–24 x 1½ in. (4)
11 Washer, lock, ⅜ in. (4)
12 Strainer cover
13 Preformed packing
14 Screw, cap, hex-head, ⅜–24 x ⅝ in (3)
15 Washer, lock ⅜ in (3)
16 Washer, flat, ⅜ in. (3)
17 Filler strainer
18 Magnet and strainer cage
19 Bail
20 Baffle
21 Outlet strainer
22 Magnet
23 Preformed packing
24 Screw, cap, hex-head, ½–13 x 1½ in. (8).
25 Washer, lock, ½ in. (8)
26 Flange half (4)
27 Preformed packing (2)
28 Hose clamp (4)
29 Hose
30 Tube, valve to reservoir
31 Tube, valve to reservoir
32 Screw, cap, hex-head, ½–13 x 5½ in. (4)
33 Nut, ½–13 (4)
34 Washer, lock, ½ in. (4)
35 Control valve assembly
36 Screw, cap, hex-head, ½–13 x 1¾ in. (2).
37 Nut, ½–13 (2)
38 Washer, lock, ½ in. (2)
39 Washer, flat, ½ in. (2)
40 Nut, ⅜–24
41 Washer, lock, ⅜ in.
42 Screw, cap, hex-head, ⅜–24 x 1½ in.
43 Washer, flat, ⅜ in.
44 Valve bracket
45 Fluid level gage
46 Drain plug
47 Gasket
48 Reservoir

Figure 5–10—Continued.

Section VII. HYDRAULIC CONTROL VALVE

5–13. General

a. The control valve enables the operator to direct a flow of hydraulic oil to the cylinders to operate the loader. The valve includes three operating spools.

(1) The upper spool (21, fig. 5–11) controls the boom circuit.

(2) The center spool (30, fig. 5–11) controls the bucket circuit.

(3) The lower spool (31, fig. 5–11) controls the clam circuit.

b. When the spools are in neutral position the oil flow from the pump is directed through the valve and to the outlet port and returns to the reservoir. When a spool is moved by the control linkage, the bypass is closed and oil flows through the spool load check valve to the desired cylinder port. At the same time a port at the opposite end of the cylinder is opened to allow oil to flow to the outlet port of the control valve. The load check valves prevent flow of oil back from the cylinder as the spool is moved to transmit power to the port. Make up valves equalize pressure within the cylinder when the spool is returned to neutral. The main relief valve protects the circuits when the circuits are energized.

c. When inlet (or oil from pump) oil pressure exceeds the main relief valve setting, the relief valve plunger is forced open, allowing the excess pressure to bypass through the valve outlet port preventing overloading of the energized circuit.

5–14. Hydraulic Control Valve

a. Removal.

(1) Refer to TM 5–3805–239–12 and disconnect the control linkage from the control valve.

(2) Refer to TM 5–3805–239–12 and disconnect hoses and tubes from the control valve.

(3) Remove four screws (24, fig. 5–10) and lock washers (25) and remove tube (31), flanges (26), and packing (27) from control valve.

(4) Remove four screws (32), nuts (33), and lock washers (34) and remove control valve (35) from bracket.

b. Disassembly. Before starting disassembly procedures, clean exterior of valve and ports with cleaning compound, solvent (Spec. P–S–661) and dry thoroughly.

(1) Remove screws (1, fig. 5–11) and re-

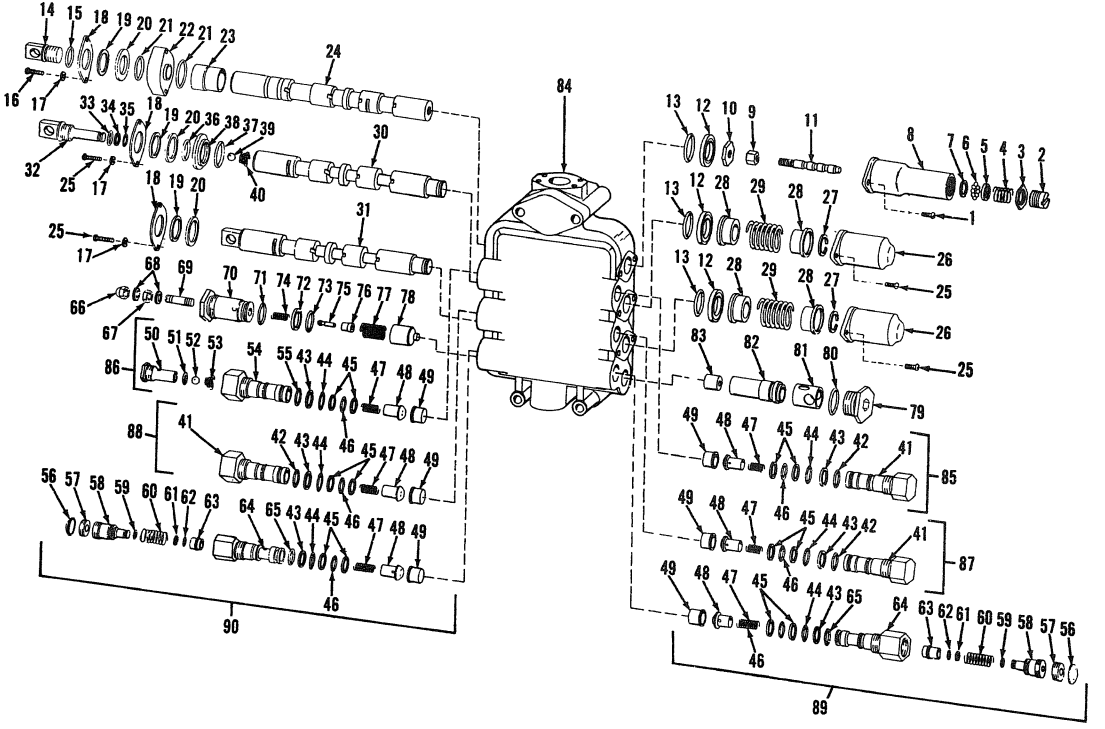


Figure 5-11. Hydraulic control valve, exploded view.

1 Screw (2)
2 Adjusting screw
3 Lock nut
4 Spring
5 Detent cam
6 Ball, detent (8)
7 Detent washer
8 Cover
9 Lock nut
10 Nut
11 Detent stud
12 Retainer (3)
13 Packing, preformed (3)
14 Boom spool eye
15 Packing, preformed
16 Screw (2)
17 Washer, lock (6)
18 Retainer (3)
19 Wiper (3)
20 Retainer (3)
21 Packing, preformed (2)
22 Extension housing
23 Wear sleeve
24 Boom spool
25 Screw (8)
26 Cover (2)
27 Ring, retaining (2)
28 Spring retainer (4)
29 Return spring (2)
30 Bucket spool
31 Clam spool
32 Bucket spool eye
33 Packing, preformed
34 Backup ring
35 Packing, preformed
36 Packing, preformed
37 Packing, preformed
38 Retainer
39 Ball
40 Spring
41 Check valve cap (3)
42 Packing, preformed (3)
43 Backup ring (6)
44 Packing, preformed (6)
45 Backup ring (12)
46 Packing, preformed (6)
47 Spring (6)
48 Check valve (6)
49 Seat (6)
50 Valve seat
51 Packing, preformed
52 Ball
53 Spring
54 Check valve cap
55 Packing, preformed
56 Expansion plug (2)
57 Locking nut (2)
58 Spring guide (2)
59 Packing, preformed (2)
60 Spring (2)
61 Backup ring (2)
62 Packing, preformed (2)
63 Relief valve (2)
64 Cap (2)
65 Packing, preformed (2)
66 Acorn nut
67 Lock nut
68 Seal (2)
69 Adjusting screw
70 Main relief valve cap
71 Packing, preformed
72 Backup ring
73 Packing, preformed
74 Spring
75 Relief valve plunger
76 Seat
77 Spring
78 Plunger
79 End plug
80 Packing, preformed
81 Spacer
82 Seat holder
83 Valve seat
84 Valve body
85 "Raise" circuit load check valve
86 "Lower" circuit load check valve and "Boom" circuit makeup valve
87 "Clam open" circuit load check valve.
88 "Clam close" circuit load check valve
89 "Dump" circuit overload relief valve
90 "Retract circuit" overload check valve

Figure 5-1 - Continued.

move cover (8). Remove adjusting screw (2), lock nut (3), and spring (4) from cover. Carefully remove detent cam (5), balls (6) and, washer (7). Do not damage or lose balls.

(2) Remove boom spool (24) from body. Remove nut (10) and lock nut (9) and remove detent stud from spool. Remove eye (14).

(3) Remove retainer (12) and packing (13) from body.

(4) Remove screws (16) and lock washers (17) and remove retainer (18) and housing (22). Remove retainer (20), packing (21) and wiper (19).

(5) Remove two screws (25) and remove cover (26). Remove bucket spool (30) and attached parts from body. Remove retainer (12) and packing (13) from body.

(6) Clamp the spool in a vise with copper jaws. Compress spring (29) and remove retaining ring (27) from spool. Remove spring (29) and spring retainers (28).

(7) Remove eye (32), packing (33), backup ring (34) and packing (35). Remove ball (39) and spring (40).

(8) Remove two screws (25) and lock washers (17) and remove retainer (18), wiper (19), retainers (20 and 38) and packings (36 and 37).

(9) Remove two screws (25) and remove cover (26). Remove clam spool (31) and re-

move retaining ring and parts as described in (6) above.

(10) Remove two screws (25) and lock washers (17) and remove retainers (18 and 20) and wiper (19).

(11) Remove bucket check valve (85) and clam check valve (87). Remove check valve caps (41), two packings (42), two backup rings (43), two packings (44), four backup rings (45), and two packings (46). Remove two springs (47) and check valves (48). Do not remove seats (49). Use a soft wire to reach into bore to remove springs and valves.

(12) From other side of body, remove cap (41), packings, backup rings, spring, and valve. Do not remove seat (49).

(13) Remove valve seat (50), packing (51), ball (52) and spring (53). Remove check valve cap (54) and packing (55). Remove remainder of parts as described above. Do not remove seat (49).

(14) Remove two expansion plugs (56) and remove nuts (57), spring guides (58), packings (59), springs (60), backup rings (61), packings (62) and relief valves (63) from caps (64).

(15) Remove caps (64), packings and backup rings (65, 43, 44, 45, and 46). Remove springs (47) and check valves (48) using a soft wire. Do not remove seats (49).

(16) Remove acorn nut (66), lock nut (67) and seals (68) from adjusting screw (69). Remove adjusting screw from main relief valve cap (70). Remove cap and packing (71).

(17) Remove backup ring (72) and packing (73). Remove relief valve plunger (75) and spring (77) from plunger (78). Do not remove seat (76) from cap. Remove plunger (78).

(18) Remove end plug (79) and packing (80). Remove spacer (81) and seat holder (82). Do not remove seat (83) from holder.

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

d. Inspection and Repair.

(1) Replace all gaskets, preformed packings, and backup rings.

(2) Inspect valve body for cracks, nicks, wear, and damage. Inspect body for evidence of leakage. Replace worn or damaged bodies.

(3) Check fit of spools in body bores. Spools should fit with a slight hand pressure and without any perceptible side clearance. If spools are loose, scored, or damaged, or the valve body is worn or damaged, replace the entire control valve.

(4) Inspect check valves and seats for grooves or defects. Check the valves for free movements in cap bores. Replace all faulty valves.

(5) Inspect boom spool wear sleeve for damage and wear. Replace unserviceable sleeves.

(6) Inspect relief valve plungers and seats for ridges, scoring, and wear in the seating areas. Replace damaged or worn parts.

(7) Check all parts against tolerances listed in table 1–1. Replace all parts not conforming to tolerances listed in the repair and replacement standards.

e. Reassembly. Check to see that all parts are clean before reassembling. Coat all valve parts and body bores with engine oil (OE) before assembling.

(1) Clamp the boom spool (24, fig. 5–11) in a vise with copper jaws. Install retainer (12) and packing (13) on spool. Install detent stud (11) nut (10) and lock nut (9) on spool. Apply a thread sealant to detent stud threads before installation.

(2) Install washer (7), balls (6), and cam (5) in cover (8). Install spring (4), nut (3), and adjusting screw (2) in cover. Slide detent stud into cover through balls, with balls entering a detent in the stud.

(3) Carefully install boom spool assembly through bore in body. Install screws (1) to secure cover. Do not tighten screws at this time.

(4) Install packing (15) on eye (14) and install eye in spool. Install wear sleeve (23), packings (21), retainer (20), wiper (19), housing (22), and retainer (18). Secure retainer with two screws (16) and lock washers (17). Tighten screws (1).

(5) Clamp buckets spool (30) in a vise with copper jaws. Install spring retainers (28) and spring (29) on spool. Compress springs and install a new retaining ring (27) in groove in spool.

(6) Turn spool in vise to bring eye end up. Install spring (40) and ball (39) on spool. Install packings (33 and 35) and backup ring (34) on eye (32). Install eye securely on spool.

Install packing (13) and retainer (12) on spool.

(7) Install assembled spool in bore in body. Install packings (36 and 37) and retainer (38). Install retainer (20), wiper (19), and retainer (18). Check seating of packings and secure retainer with two screws (25) and lock washers (17). Install cover (26) and secure with two screws (25).

(8) Install clam spool (31) in a vise with copper jaws. Install spring retainers (28) and spring (29) on spool. Compress spring and install new retaining ring (27) in groove in spool. Install packing (13) and retainer (12) on spool.

(9) Install spool in bore in body. Install wiper (19) and retainer (20) and secure with two screws (25) and lock washers (26). Install cover (26) and secure with two screws (25).

(10) Install "Raise" circuit load check valve (85) by installing packings (42, 44, and 46) and backup rings (43 and 45) on load check valve cap (41). Install check valve (48) and spring (47) in bore in body and install assembled cap (41).

(11) Install "Lower" circuit load check valve (86) by installing packing (51) on valve seat (50) and installing valve seat, spring (53) and ball (52) in check valve cap (54). Install packings (44, 46, and 55) and backup rings (43 and 45) on check valve cap. Install spring (47) and valve (48) in body and install assembled check valve cap (54) in body.

(12) Install "Clam open" and "Clam close" circuit load check valves (87 and 88) in the same manner as "Raise" and "Lower" valves. "Clam close" circuit load check valve does not have a valve seat (50) in the cap (41).

(13) Install both "Dump" circuit and "Retract" circuit check valves (89 and 90) in the same manner.

(*a*) Install packings (59) on spring guides (58). Install relief valves (63), packings (62), backup rings (61), spring guide (58), and locking nuts (57) in check valve caps (64).

(*b*) Install packings (44, 46, and 65) and backup rings (43 and 45) on check valve caps (64). Install valves (48) and springs (47) in body and install check valve caps in body. Do not install expansion plugs (56) at this time.

(14) Install main pressure relief valve as follows:

(*a*) Install packing (80) on end plug (79) and install valve seat (83), seat holder (82) and spacer (81) in bore in body. Install end plug into bore in body.

(*b*) Install packings (71 and 73) and backup ring (72) on main relief valve cap (70). Install relief valve plunger (75) in spring (74) and install spring and plunger in bore of relief valve cap (70) with plunger pointing toward seat (76).

(*c*) Install adjusting screw (69), seals (68) and lock nut (67) on valve cap. Install acorn nut (66) on adjusting screw.

(*d*) Install plunger (78) and spring (77) in bore in body.

(*e*) Install assembled main relief valve cap in bore in valve body.

f. Installation.

(1) Install hydraulic control valve (35, fig. 5–10) on bracket and secure with four screws (32), nuts (33), and lock washers (34).

(2) Install tube (31) and packing (27) on control valve and secure with two flanges (26) and four screws (24) and lock washers (25).

(3) Refer to TM 5–3805–239–12 and connect remaining hoses and tubes to control valve.

(4) Refer to TM 5–3805–239–12 and connect the control linkage to the control valve.

g. Testing and Adjustment.

(1) Check system by observing operation.

(2) With oil at operating temperatures, check time to raise empty bucket from ground to full raise position with engine at fast idle speed.

(3) Time should be approximately 6 seconds.

(4) If bucket raises slowly, check hydraulic system for the following:

(*a*) Proper level of oil in reservoir.

(*b*) Oil of proper specification.

(*c*) Unrestricted suction line and clean strainer.

(*d*) Correct fast idle rpm.

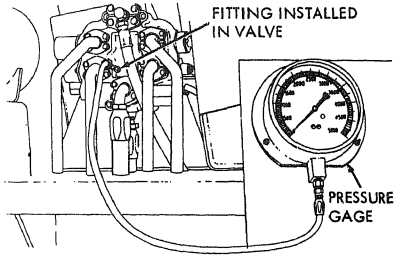
(*e*) Properly operating power steering pump and demand valve.

(5) Repeat test ((2) above) with a loaded bucket. If lifting time is good with an empty bucket but is slow with a loaded bucket, check

cylinder packing, main relief valve, or hydraulic pump.

(6) Test main relief valve. Open access door on right side of loader. With engine stopped, remove plug from body of valve. Install a fitting (fig. 5–12) in threaded hole from which plug was removed.

Note. Fitting must have 7/16–20 thread, with packing, and must connect with a ¼ inch outside diameter tube fitting.



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Figure 5–12. Testing main relief valve.

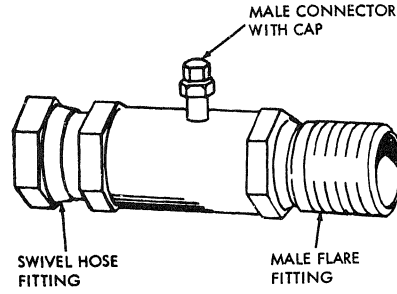
(7) Connect a 0 to 3000 psi gage to the fitting as illustrated in figure 5–12.

(8) Start engine and operate until hydraulic oil temperature reaches 150° F. Lower bucket to the ground, retract bucket all the way and hold boom control lever in LOWER position. Check pressure reading on gage. Reading should be 1750 to 1850 psi.

Note. Do not hold boom control lever in LOWER position for long periods of time.

(9) Remove acorn nut (66, fig. 5–11) and loosen lock nut (67). Turn adjusting screw (69) ¼ turn at a time and check pressure reading.

Note. To increase pressure, turn adjusting screw clockwise. To decrease pressure, turn adjusting screw counterclockwise.

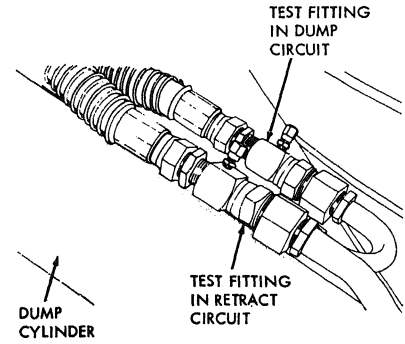


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Figure 5–13. Overload relief valve test fitting.

(10) When correct pressure has been reached, hold adjusting screw and tighten lock nut. Install acorn nut. Stop engine.

(11) Disconnect gage hose from fitting (fig. 5–12). If fitting is to be left in valve for test



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Figure 5–14. Typical test fittings installed in dump cylinder circuits.

purpose, install a cap on fitting. If not, remove fitting and install pipe plug in valve body.

(12) Test overload relief valves. Overload relief valves seldom require adjustment. To test the relief valves it will be necessary to install a fabricated fitting in the circuit to be checked.

(*a*) Fabricate a fitting as illustrated on figure 5–13.

(*b*) Modify and weld together a ¾ tube to 1 15/16–12 hose swivel hose fitting and a 1.000 tube to 1 15/16–12 hose male flare fitting. Drill and tap a ⅛ NPT hole and install a ⅛ NPT to ¼ tube male connector in the tapped hole. Install a ¼ flared tube cap on connector.

(13) Install fabricated test fitting as illustrated in figure 5–14 between the control valve and the cylinder tubing.

(14) Remove cap (fig. 5–13) from fitting and connect pressure gage (fig. 5–12) to male connector.

(15) Test the dump circuit overload relief valve as follows:

(*a*) Start engine and operate until hydraulic oil temperature reaches 150° F.

(*b*) With bucket on ground, place bucket control lever in DUMP position to fully dump bucket.

(*c*) With engine operating at low idle move boom control lever to RAISE position and allow boom to raise all the way to the top. During the lifting cycle the cross link will contact the stops and drive dump cylinder piston rods all the way in and open the overload relief valve.

(*d*) Check pressure on gage at which valve opens. Pressure should be 825 to 1025 psi.

(*e*) Lower bucket to ground and repeat step (*c*) with engine at fast idle. Check pressure gage. Pressure should be as noted above.

(*f*) If pressure is not correct, adjust by removing locking nut (57, fig. 5–11) and rotating spring guide (58) of relief valve (89) clockwise to increase pressure and counterclockwise to decrease pressure.

(*g*) Install locking nut and expansion plug (56).

(*h*) Stop engine, disconnect pressure gage from test fitting in dump circuit (fig. 5–14) and install cap on connector.

(16) Test retract circuit as follows:

(*a*) Connect test fitting in retract circuit as illustrated on figure 5–14.

(*b*) Remove cap and connect pressure gage to connector.

(*c*) Start engine and operate until hydraulic oil reaches a temperature of 150° F.

(*d*) Raise boom until bucket can be retracted against stops with the dump cylinders fully closed. Retract bucket until stops are contacted.

(*e*) With engine at low idle, place boom control lever in LOWER position. Boom should go all the way to the bottom. Dump cylinder rods will be forced all the way out opening the overload relief valve.

(*f*) Check pressure at which the relief valve opens. Pressure should be 2300 to 2500 psi.

(*g*) Operate engine at fast idle and repeat step (*e*). Pressure should be as noted above.

(*h*) If pressure is not correct, adjust by removing locking nut (57, fig. 5–11) and rotating spring guide (58) of relief valve (90) clockwise to increase pressure and counterclockwise to decrease pressure.

(*i*) Install locking nut and expansion plug (56).

(*j*) Stop engine, disconnect pressure gage and install cap on connector.

(17) Remove test fittings, if desired, or leave in for ease of future testing.

(18) Operate loader and check hydraulic system for proper operation and any leakage.

(19) The clam control circuit is protected by the safety valve mounted at the rear of the bucket. This valve will open to prevent overloading of the circuit.

CHAPTER 6
POWER STEERING SYSTEM REPAIR INSTRUCTIONS

Section I. STEERING GEAR

6–1. General

a. The power steering system is a hydraulically assisted recirculating ball bearing worm and nut type. Power steering assists the operator when manuvering the vehicle under all loads and terrain operating conditions.

b. The power steering system incorporates the steering gear with integral power steering control valve, a power steering hydraulic pump, and two double-acting power steering cylinders.

6–2. Steering Gear

a. General. The steering gear consists of a steering shaft enclosed in a tube. The shaft carries the steering wheel at the upper end and a worm at the lower end. The worm rides in a recirculating ball bearing nut which meshes with the steering arm sector gear. The shaft also carries a power steering control (spool) valve which controls and directs the flow of hydraulic oil under pressure to the steering cylinders.

b. Removal. Remove steering gear assembly (para 2–33).

c. Disassembly.

(1) Clean exterior of steering gear with cleaning compound solvent (Spec. P–S–661) and dry thoroughly with compressed air. Place steering gear in a vise.

(2) Scribe or punch match marks on the jacket cover (3, fig. 6–1), valve body (10), valve adapter (17) and steering gear housing (29) to insure correct reassembly.

(3) Remove three screws (1) and lock washers (2).

Note. It may be necessary to tap the jacket cover lightly to remove the cover. Use suitable means to protect the splined end of the steering shaft.

(4) Remove the jacket cover assembly (3) from the steering gear.

(5) Remove packing (4) and discard. Do not remove oil seal (5) unless replacement is necessary.

(6) Remove staked spool lock nut (7). Remove preload spring washer (8) and upper bearing (9).

Note. Use care when removing staked lock nut to avoid damage to steering shaft threads.

Note. Retain bearing races and bearing as a group and install together during reassembly.

(7) Remove valve body (10) as an assembly. Be careful not to lose plungers (11) and springs (12) from body. Carefully remove valve spool (13).

Note. Note which end of the spool has a groove or counterbore on the inside diameter.

(8) Remove plungers (11) and springs (12). Remove lower bearing (14).

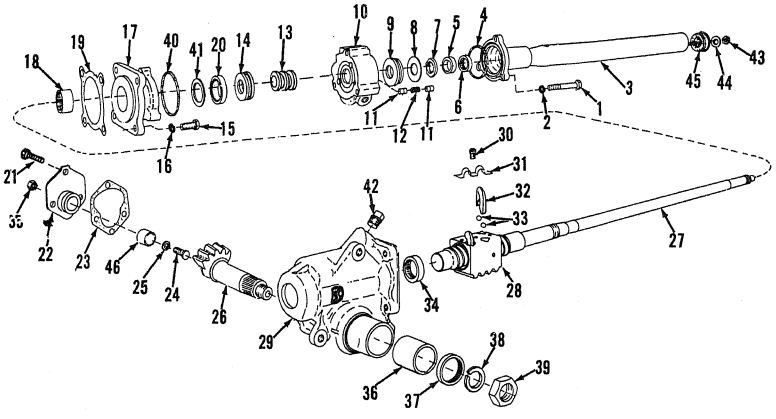
(9) Remove four screws (15) and lock washers (16). Remove adapter (17). Do not remove bearing (18) from adapter unless replacement is necessary. Remove gasket (19) and discard. Do not remove oil seal (20) unless replacement is necessary.

(10) Remove four screws (21). Remove side cover (22) and gasket (23). Discard gasket.

Note. Remove side cover by turning lash adjuster screw (24) clockwise through the side cover.

(11) Remove lash adjuster screw (24) and shim (25) from slotted end of sector gear (26). Turn steering shaft until sector gear on shaft will pass through housing opening.

(12) Carefully remove steering gear shaft (27) and ball nut (28) from housing (29). Place shaft with ball nut in a vertical position and allow ball nut to move down to the end of the shaft under its own weight.



MEC 3805-239-35/6-1

1 Screw, cap, hex-head (3)
2 Washer, lock (3)
3 Jacket cover
4 Packing, preformed
5 Oil seal
6 Bearing
7 Nut
8 Spring washer
9 Bearing
10 Steering valve body
11 Plunger (6 rqr)
12 Spring (3 rqr)
13 Valve spool
14 Bearing
15 Screw, cap, hex-head, 7/16–14 x 1½ in. (4)
16 Washer, 1 ock, 7/16 in. (4)
17 Adapter
18 Bearing
19 Gasket
20 Oil seal
21 Screw, cap, hex-head, 7/16–14 x ¾ in. (4)
22 Cover
23 Gasket
24 Lash adjuster screw
25 Shim (as rqr)
26 Sector gear
27 Steering shaft
28 Ball nut
29 Steering gear housing
30 Screw (3)
31 Clamp
32 Ball guide (4)
33 Ball (106)
34 Bearing
35 Nut
36 Bearing, sleeve
37 Oil seal
38 Washer, lock
39 Nut
40 Packing, preformed
41 Washer, flat
42 Plug
43 Nut
44 Washer
45 Bearing
46 Bearing, sleeve

Figure 6–1. Steering gear, exploded view.

Note. Do not allow ball nut to strike sharply at either end of the worm to avoid damage to ball guides. If ball nut does not require disassembly, tape each end of worm to prevent nut from traveling to either end.

(13) Move ball nut on shaft worm. The ball nut must rotate smoothly, with no evidence of binding or roughness. If there are indications of damage remove three screws (30) and

clamp (31). Remove two ball guides (32), one at a time. Separate guides and remove balls (33). Turn ball nut upside down and rotate shaft back and forth until all the balls have dropped out onto a clean pan. Remove ball nut from worm on shaft after all balls have been removed.

d. Cleaning.

(1) Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

(2) Coat all parts that are to be reused with a light film of engine oil (OE).

e. Inspection and Repair.

(1) Inspect spool and valve body for signs of damage. If these parts are damaged the valve body and spool must be replaced as an assembly.

(2) Inspect centering springs for damage or distortion; replace if necessary. Inspect plungers for nicks or scratches. Replace damaged plungers.

(3) Inspect small and large bearing races for nicks, scratches and out-of-roundness. Replace defective wearings.

(4) Discard all packings and gaskets.

(5) Inspect all needle bearings. The rollers should be smooth, polished and free to turn in their retainer. If bearings show any sign of wear or damage, replace bearings.

Note. Press new bearings in place with trademark side out.

(6) Examine steering gear housing for cracks or stripped threads. If shaft is damaged, replace shaft and housing as an assembly.

(7) Examine side cover for cracks and damage. Check clearance between shaft and side cover bearing. If bearing shows signs of scoring, damage or excessive wear, replace side cover and sleeve bearing as an assembly.

(8) Examine sector teeth for signs of scuffing or scoring. Check outside diameter of shaft. Replace shaft if excessive wear is found in any of the above steps. Replace oil seals if cracked or damaged.

(9) Inspect bearing area and thread groove on the worm shaft. If worn or galled, replace steering shaft and complete ball nut assembly.

(10) Inspect ball nut rack teeth for scuffing and scoring. Check all holes and passages for obstructions. Check all balls for wear, flat spots, and damage. Balls should be the same size within 0.0001 inch.

(11) Examine ball guides for distortion and bent pickup fingers. Place both halves of a guide together and check action of balls.

(12) Check all parts against tolerances listed in table 1–1. Replace all parts not conforming to repair and replacement standards.

f. Reassembly.

Note. One of the most important phases of reassembly is cleanliness. All parts must be kept clean and preoiled. Any abrasive particles present will quickly damage the mechanism. Grease and oil must be fresh and free from dirt. Prelubricate worm, ball nut, bearings and sector gear. Fill gear housing to normal operating capacity with grease (GAA).

(1) Place steering shaft (27, fig. 6–1) flat on a bench. Place ball nut (28) over worm, with ball return guide holes facing upward.

Note. Aline groove in worm and ball nut by sight.

(2) Count and separate half of the total number of balls (33) used in the ball nut. Drop the balls into one of the ball return guide holes in the upper circuit. Gradually turn the worm away from the hole while inserting balls.

Note. Continue until the circuit is filled from the top of one hole to the bottom of the other, or until the balls reach the end of the worm and stop.

(3) If the balls are stopped by reaching the end of the worm, hold down the balls already inserted with a rod or punch. Turn the steering shaft in the reverse direction and continue the filling operation. Work the shaft back and forth, holding the balls down, first in one hole, then in the other. This will close up the spaces between the balls and allow complete filling of the circuit.

(4) Place one half of the ball guide (32) on a bench, groove up. Place remaining balls in groove of guide. Cover ball guide with other half of guide and plug ends with grease to prevent the balls from dropping out.

(5) Push filled ball return guide (32) completely into holes in ball nut.

(6) Fill the lower circuit in the ball nut as described above. Install ball return guide clamp (31) on ball nut and install and tighten screws (30) securely.

Note. Be certain ball nut and balls are well lubricated. Test assembly by rotating ball nut on worm. DO NOT ROTATE BALL NUT TO END OF WORM THREADS. The assembly must move freely. Use tape to hold ball nut on worm until ready to install.

(7) Remove tape. Grip nut and insert steering shaft through upper opening in gear housing (29), guiding the shaft carefully into the lower housing bearing (34).

(8) Insert sector gear (26) through cover opening and aline sector teeth with ball nut.

Note. Turn steering shaft until ball nut is in the approximate center of the shaft worm. Center tooth of sector gear must enter center tooth space of ball nut.

(9) Grease cover gasket (23) lightly. Place on cover (22) or housing and aline. Install lash adjuster screw (24), original shim (25), and nut (35).

Note. Check clearance between adjuster screw and shaft. Clearance must not exceed 0.0020 inch. If clearance is greater, use a thicker shim (0.0630, 0.0650, 0.0670 and 0.690 inch thick shims are available).

(10) Place cover (22) over end of shaft and turn lash adjuster screw (24) to pull cover in place. Back off adjuster screw. Install screws (21) and tighten securely.

(11) With sector gear on center, turn in adjuster screw until 1¼ to 1½ pounds pull on the rim is required to turn an 18" diameter steering wheel through a 3 inch arc.

(12) Tighten nut (35). Recheck pull. Total pull after adjusting should be 1⅛ to 2 pounds over center on an 18" diameter steering wheel.

(13) Install steering arm oil seal (37). If previously removed, install adapter bearing (18) and oil seal (20). Install adapter gasket (19) and carefully position adapter (17) over steering gear shaft (27) to avoid damaging gasket.

(14) Secure adapter to gear housing assembly (29) with four screws (15) and lock washers (16). Tighten screws to a torque of 20 to 25 foot-pounds.

(15) Install bearing (14) into adapter assembly. Install new packing (40). Install lock washer (38) and nut (39) on steering arm shaft and secure finger tight.

(16) Carefully place control valve body (10) over steering gear assembly and lower into position.

Note. Match marks or scribe marks must be properly alined for correct assembly.

(17) Coat plungers (11) and control valve spool (13) with engine oil (OE). Insert one plunger (11) into each of the valve body bores. Insert one centering spring (12) into each of the valve body bores. Install the remaining plungers into each of the valve bores.

(18) Install spool (13) in valve body (10) with groove on inside diameter of valve at same end in relation to valve body as was noted during disassembly.

Note. Do not force spool into valve body. Spool will drop into place when properly alined. Forcing spool will damage both the spool and the valve bore.

(19) Install bearing (9) over steering gear shaft and lower onto control valve assembly. Place preload spring washer (8) on bearing assembly. Install new lock nut (7).

(20) Install three screws (1) and lock washers (2) through jacket cover (3) ring and tighten into adapter to prevent the jacket cover from turning.

(21) Grip steering wheel to prevent shaft from turning and tighten lock nut (7) to a torque of 20 to 30 foot-pounds. Back off the lock nut about ¼ turn and stake the nut to the groove in the shaft.

Note. Support shaft from the opposite side of the groove while staking the nut to prevent damage to shaft.

(22) Install bearing oil seal (5) and packing (4) in jacket cover assembly (3).

Note. Tape splined end of steering gear shaft to protect seal in cover assembly.

(23) Install jacket cover assembly (3) over steering gear shaft (27). Remove three screws (1) and lock washers (2) installed previously. Install three screws (1) and lock washers (2) and secure cover assembly to valve assembly and adapter assembly.

(24) Remove steering gear lubricant filler plug (42) and add 1½ pounds of grease (GAA). Install filler plug and tighten securely.

g. Installation. Install steering gear (para 2–33).

Note. Tighten hydraulic hose assembly fittings to a torque of 20 to 30 foot-pounds to prevent oil leakage.

h. Adjustments.

(1) Lash adjustment is required whenever an excessive amount of steering wheel play becomes perceptible. Adjustment procedure is given below.

(*a*) Disconnect tie rod from steering arm. Turn steering wheel slowly from lock to lock and return to center position .

(*b*) Attach a spring scale to spoke of steering wheel to measure rim (9" radius) pulling effort required to move wheel over center.

(*c*) Turn lash adjuster screw (24, fig. 6–1) until backlash just disappears. When ad-

1⅛ to 2 pounds for a 3 inch wheel arc over center.

(*d*) Tighten lash adjuster screw locknut (35) to a torque of 25 to 35 foot-pounds.

Note. Make certain lash adjuster screw does not move while tightening nut.

(*e*) Connect tie rod to steering arm.

(2) Thrust adjustment will not be required normally. Adjustment procedure is given below.

(*a*) Disconnect tie rod from steering arm and remove steering wheel from steering shaft. Refer to TM 5–3805–239–12.

(*b*) Remove steering gear covers (para 2–33) from floor plate. Remove instrument panel U-bolt (para 2–33).

(*c*) Remove steering gear cover (3, fig. 6–1) bearing, and seal assembly as a unit.

(*d*) Replace valve screws (1, fig. 6–1) using a ½ inch stack of washers under each screw to stimulate gear cover thickness. Tighten screws to a torque of 17 to 23 foot-pounds.

(*e*) Tighten adapter to gear housing screws (15) to a torque of 25 to 35 foot-pounds. Loosen lock nut (35) and back off lash on worm gear.

(*f*) Remove staked nut (7) from steering shaft.

Caution: **Do not remove preload spring washer (8) immediately below the locknut.**

(*g*) Install a new lock nut (7). Place steering wheel on shaft and rotate steering shaft at least one full turn to right or left of center.

Caution: **Do not turn wheel to extreme right or extreme left position.**

(*h*) Tighten shaft lock nut to a torque of 20 to 30 foot-pounds to seat thrust bearing. Back off lock nut ¼ turn and stake in place.

(*i*) Remove screws (1) and ½ inch stacks of washers from valve assembly. Place steering gear assembly jacket cover (3), bearing and seal over steering shaft and slide into place.

(*j*) Install screws (1) and lock washers (2) and tighten to a torque of 17 to 23 foot-pounds.

Note. Perform lash adjustment ((1) above) after completing thrust adjustment procedure.

Section II. HYDRAULIC SYSTEM

6–3. General

a. The hydraulic system includes a hydraulic pump, reservoir, connecting high-pressure hoses, and two double-acting hydraulic cylinders. The hydraulic system provides hydraulic oil under pressure to assist in maneuvering the vehicle under all loads and terrain conditions. The output of the hydraulic system is directed by a power steering control valve integral to the steering gear.

b. The cylinders are connected to the front and rear sections of the loader. As the cylinder rods extend and retract the sections pivot on the center pins, providing the steering action.

6–4. Power Steering Hydraulic Pump

a. General. The power steering hydraulic pump is a positive displacement gear type gear driven from the transmission power take-off. Output is sufficient to operate the power steering system at engine speeds above low idle. At low idle engine speeds, a demand valve provides additional oil under pressure from the main hydraulic pump to maintain full steering assist. Excess oil is bypassed to the hydraulic reservoir.

b. Removal. Refer to TM 5–3805–239–12 and remove power steering hydraulic pump.

c. Disassembly.

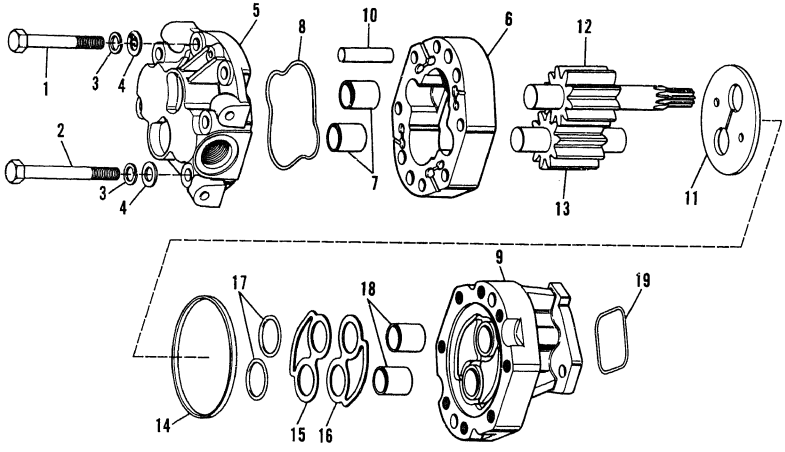
(1) Clean exterior of power steering hydraulic pump using cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air. Scribe or punch match marks on pump cover (5, fig. 6–2), housing (6) and adapter (9).

(2) Remove eight screws (1 and 2), lock washers (3) and washers (4).

(3) Carefully tap cover (5) and remove from housing (6). Do not remove bearings (7) unless replacement is required. Remove preformed packing (8) and discard.

(4) Carefully tap adapter cover (9) and remove cover. Do not remove dowel pins (10) unless replacement is required.

(5) Remove driving gear (12) and driven



1 Screw, cap, hex-head, 5/16 in. x 2-1/2 in. (4 rqr)
2 Screw, cap, hex-head, 5/16 in. x 3-1/2 in. (4 rqr)
3 Washer, lock, 5/16 in. (8 rqr)
4 Washer, flat, 5/16 in. (8 rqr)
5 Cover
6 Housing
7 Bearing, sleeve (2 rqr)
8 Preformed packing
9 Adapter
10 Dowel pin (2 rqr
11 Wear plate
12 Gear assembly, driving
13 Gear assembly, driven
14 Gasket
15 Gasket
16 Gasket
17 Preformed packing (2 rqr)
18 Bearing, sleeve (2 rqr)
19 Preformed packing

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Figure 6-2. Power steering pump, exploded view.

gear (13). Remove wear plate (11). Remove and discard gaskets (14, 15, and 16). Remove packings (17). Do not remove bearings (18) unless replacement is required. Remove packing (19).

d. Cleaning.

(1) Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

(2) Coat all parts that are to be reused with a light film of engine oil (OE).

e. Inspection and Repair.

(1) Inspect bearings in cover assembly and adapter for wear and distortion.

Note. If a defective bearing is found in the cover or in the adapter, the entire pump assembly must be replaced.

(2) Inspect gears for burs, gouges, score marks and pick-up. Stone teeth lightly to remove any burs or pick-up. The face of the gears should be sharp and square with the gear teeth. The gear edges must be free from burs, but never rounded. If any of the above defects cannot be removed to a satisfactory finish, the entire pump assembly must be replaced.

(3) Inspect adapter, housing, and cover for cracks. If any cracks are found in these parts, the entire pump assembly must be replaced.

f. Reassembly.

(1) Install new packing (19, fig. 6–2) in adapter (9). Install new packings (17) in recess groove around bearings in adapter.

(2) Install gaskets (15 and 16) into adapter. Install wear plate (11) with bronze side of plate facing gears. Install gasket (14) around wear plate.

(3) If previously removed, install two dowel pins (10) in housing (6) using an arbor press. Install housing on adapter (9) making sure marks are alined.

Note. It may be necessary to tap the housing into place.

(4) Install splined end of drive gear (12) into the adapter and carefully push splined end through packing (19). Install driven gear (13) through wear plate and into bearing in adapter.

Note. Make certain to aline marks on gears.

(5) Install preformed packing (8) in cover (5). Aline match marks on housing (6) and cover (5) and tap cover into place.

(6) Install eight screws (1 and 2), lock washers (3) and washers (4). Do not torque screws.

(7) Rotate drive shaft gear using a 6-inch wrench.

(*a*) If gears can be rotated with only a slight drag, internal pump clearances are satisfactory.

(*b*) If gears turn with excessive drag, parts may not be seated properly or pump may be obstructed. Disassemble the pump and correct the cause. Reassemble the pump and recheck gear rotation.

(8) Tighten screws (1 and 2) to a torque of 35 to 40 foot-pounds.

g. Installation. Refer to TM 5–3805–239–12 and install power steering hydraulic pump.

Note. Tighten hydraulic hose assembly fittings to a torque of 20 to 30 foot-pounds to prevent oil leakage.

6–5. Power Steering Cylinders

a. General. The power steering cylinders are double-acting hydraulic cylinders located at the forward end of the rear frame unit, below the floor plates. The rod ends of the cylinders are attached to the forward frame assembly and the cylinder ends are attached to the rear frame unit. Depending upon the direction of the turn, oil under pressure is forced into the front end of one cylinder and the rear end of the other. Flow of oil into the cylinders is controlled by the power steering control valve mounted in the steering gear and actuated by the steering wheel.

b. Removal. Refer to TM 5–3805–239–12 and remove both power steering cylinders.

c. Disassembly.

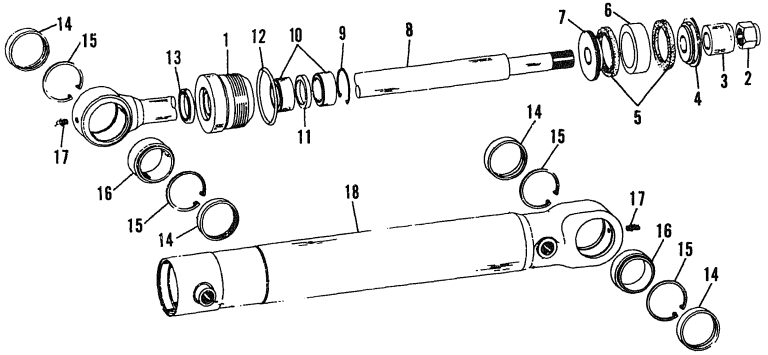
Note. Make certain open ends of hydraulic hose assemblies and cylinder ports are capped.

(1) Clean exterior of power steering cylinder(s) using cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

(2) Using a spanner wrench, loosen and remove the cylinder head (1, fig. 6–3) and pull the piston rod assembly from the cylinder tube.

(3) Remove safety nut (2) from piston rod (8). Remove the spacer (3), rear piston (4), outer piston rings (5), center piston ring (6) and front piston (7). Discard piston rings.

(4) Remove cylinder head from piston rod. Remove retaining ring (9) from cylinder



1 Cylinder head
2 Nut
3 Spacer
4 Rear piston
5 Piston ring (2 rqr)
6 Piston ring, center
7 Front piston
8 Piston rod
9 Ring, retaining
10 Bearing, sleeve (2 rqr)
11 Oil seal
12 Preformed packing
13 Oil seal
14 Oil seal (4 rqr)
15 Ring, retaining (4 rqr)
16 Bearing, sleeve (2 rqr)
17 Lubrication fitting (2 rqr)
18 Cylinder tube

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Figure 6–3. Power steering cylinder, exploded view.

head. Remove rod bearings (10) and oil seal (11).

(5) Remove packing (12) and discard. Using an arbor press, press out wiper oil seal (13) and discard.

(6) Using a puller, remove and discard oil seals (14) from each side of rod end and cylinder tube end.

(7) Remove retaining rings (15) from each side of rod end and cylinder tube end.

(8) Using an arbor press, remove the self-alining bearings (16) from rod end and cylinder tube end.

(9) Remove two lubrication fittings (17).

d. Cleaning.

(1) Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

(2) Coat all parts that are to be reused with a light film of engine oil (OE).

e. Inspection and Repair.

(1) Inspect piston rod for nicks, scratches and burs. Remove surface defects with crocus cloth or a soft stone. Replace rod if defects are too deep to be removed.

(2) Replace piston rings, packings, wiper oil seal and self-alining bearing oil seal.

(3) Check self-alining bearings and replace if worn or damaged.

(4) Inspect rod bearings in cylinder head for wear and roughness. Replace defective bearings.

(5) Inspect cylinder ports for damage to threads. If any is found, chase threads with a used tap. Replace cylinder tube if threads cannot be restored.

f. Reassembly. Reassemble power steering ylinder(s) by reversing disassembly proce- re in *c* above.

g. Installation. Refer to TM 5–3805–239–12 nd install power steering cylinders.

Note. When installing power steering cylinder(s) make certain lubrication fittings are installed at ends of piston rod and cylinder tube. Fittings should face vehicle longitudinal centerline.

CHAPTER 7
AXLE REPAIR INSTRUCTIONS

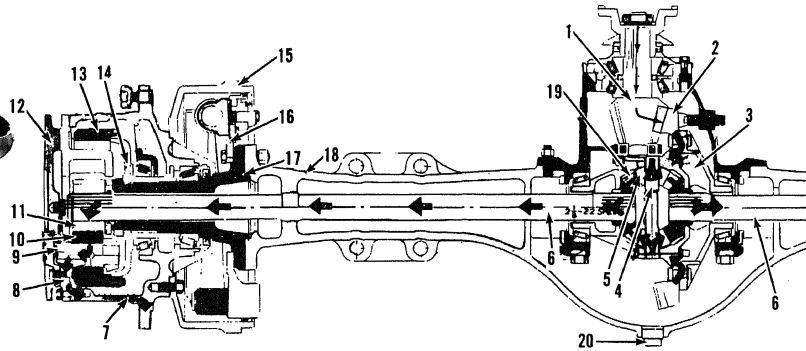
Section I. GENERAL

7–1. Description

a. The planetary rigid front and rear axles support the vehicle and transmit engine power to the driving wheels. The axles incorporate a hypoid gear set, a differential assembly, axle shafts and planetary gear sets.

b. The central differential carrier section consists of a differential assembly with hypoid type ring gear and pinion. The housing for the central section also serves as a gear oil reservoir for lubrication of these parts.

c. The planetary hubs consist of a floating gear, a floating sun gear and three planetary pinions which rotate on forged bronze planet



1 Pinion gear assembly
2 Ring gear
3 Differential case
4 Pinion carrier
5 Pinion
6 Axle
7 Brake drum
8 Hub assembly
9 Planet pinion shaft
10 Planet pinion
11 Sun gear
12 Cover
13 Ring gear
14 Planet carrier
15 Hub assembly
16 Locking plate
17 Spindle
18 Axle housing
19 Bearing cone and cup
20 Plug, level and fill

MEC 3805-239-35/7-1

Figure 7–1. Planetary rigid drive axles, cutaway view.

pins. Full flow lubrication is maintained under all operating conditions. The wheel hub and planetary spider pick up oil from the hub as they rotate, and channel it to the wheel bearings and gears and to the planet pins to lubricate the pinions.

7–2. Operation

a. Power is received from the engine through the transmission to the hypoid pinion (1, fig. 7–1), and drives the hypoid ring gear (2). Since the ring gear is attached to the differential case (3), the entire differential assembly rotates as a unit, and drives through the differential gears, dividing the power to both the right and left axle shafts (6).

b. On the outer end of each of the axle shafts (6) is mounted a planetary sun gear (11) which contacts three planetary pinions (10). These pinions mesh with a floating ring gear (13). This floating ring gear (13) is held from rotation by the ring gear carrier (14). Rotation of the axle shafts (6) causes the sun gear (11) to turn, driving the planetaries (10) around the internal gear, which makes the hub (8), brake assembly (7), and pinion shaft (9) rotate. The wheel is attached to the hub and in turn rotates driving the loader.

Section II. PLANETARY HUBS

7–3. General

The planetary hubs provide additional torque multiplication for increased vehicle tractive effort under all load and terrain conditions. The planetary gear trains are encased in removable wheel end covers. Heavy duty fixed-anchor drum type brakes are provided to control and stop the vehicle.

7–4. Planetary Hubs

a. General. The planetary hubs incorporate a floating ring gear, a floating sun gear and three planetary pinions rotating on forged bronze planet pins. All parts are lubricated by oil carried in each planetary hub.

Note. The repair instructions for the planetary hubs apply to both front and rear axles.

b. Removal. Refer to TM 5–3805–239–12 and remove wheels and tires.

(1) Block up or support axle at both ends and drain lubricant from axles and planetaries.

(2) Remove eight screws (1, fig. 7–2). Remove cover (2), and plugs (3 and 4). Remove gasket (5).

(3) Remove twelve nuts (6) and lock washers (7) from studs (8). Remove planet carrier (9) and attached parts by using puller screws in the threaded holes provided.

(4) Remove preformed packing (10).

c. Disassembly.

(1) Press out three planet pinion shafts (11, fig. 7–2). Remove three planet pinions (12), outer thrust washers (13) and inner thrust washers (14).

Note. Thrust washers are designed for opposite sides of planet pinions and can only be installed in their correct locations.

(2) Remove retaining ring (15). Remove sun gear (16), thrust washer (17), retainers (18), nut (19), and ring gear (20).

Note. Puller screw holes are provided in the ring gear hub flange to start gear.

(3) Cut lock wires and remove eight screws (21) and four locking plates (22). Remove bearing cone (23) and cup (24).

(4) Install puller screws into hub assembly (25) until they bottom against the planet carrier. Tighten puller screws alternately to remove hub assembly. If necessary for replacement, remove sleeve bearing (26) using a suitable puller.

(5) Using a box end wrench, turn brake shoe cams to the full "release" position to provide maximum clearance between brake shoes and brake drum.

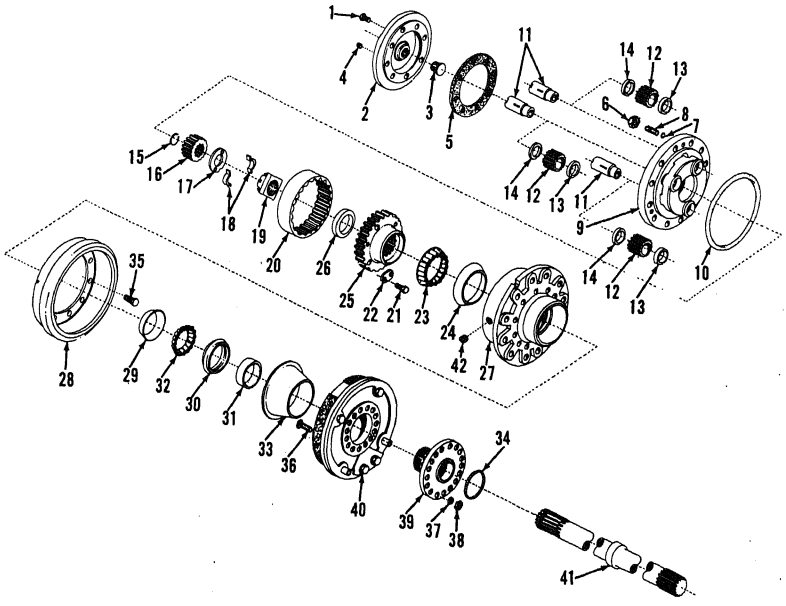
(6) Lift wheel hub assembly (27) and attached brake drum (28) to relieve weight on brake shoes, and remove as a unit. If necessary for replacement, remove bearing cup (29).

Note. Remove one brake shoe return spring to provide adequate clearance for further disassembly.

(7) Remove retainer (30), oil seal (31), and bearing cone (32). Remove oil slinger (33) and preformed packing (34).

(8) Remove 10 screws (35) and separate brake drum (28) from hub assembly (29).

(9) Remove 12 screws (36), flat washers (37) and nuts (38). Tap spindle (39) gently and remove from brake shoe assembly (40). Slide spindle carefully from axle (41).



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1 Screw, cap, hex-head (16)
2 Cover (2)
3 Plug (2)
4 Plug, pipe, ¼ in. (2)
5 Gasket (2)
6 Nut, ½ in. (24)
7 Washer, lock, ½ in. (24)
8 Stud, ½ in. (24)
9 Planet carrier (2)
10 Preformed packing (2)
11 Planet pinion shaft (6)
12 Planet pinion (3)
13 Washer, thrust, outer (6)
14 Washer, thrust, inner (6)
15 Ring, retaining (2)
16 Sun gear (2)
17 Washer, thrust (2)
18 Retainer (4)
19 Nut, retaining (2)
20 Ring gear (2)
21 Screw, cap, hex-head (16)
22 Plate, locking (8)
23 Bearing cone (2)
24 Bearing cup (2)
25 Hub assembly (2)
26 Bearing, sleeve (2)
27 Wheel hub assembly (2)
28 Brake drum (2)
29 Bearing cup (2)
30 Retainer (2)
31 Oil seal (2)
32 Bearing cone
33 Oil slinger
34 Preformed packing
35 Screw, cap, hex-head, ⅝ x 1½ in. (20)
36 Screw, cap, hex-head (24)
37 Washer, flat (24)
38 Nut (24)
39 Spindle (2)
40 Brake shoe assembly (2)
41 Axle (2)
42 Plug, ¾ in. (2)

Figure 7-2. Planetary hub and axle, exploded view.

(10) Remove plug (42) from hub assembly (27).

d. Cleaning.

(1) Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

(2) Coat all parts that are to be reused with a light film of engine oil (OE).

e. Inspection and Repair.

(1) Inspect bearing cups and cones, including parts not removed from planetary hubs. Replace all cones and cups if worn, pitted or damaged.

Note. Use a suitable puller or arbor press to remove defective parts. Avoid using a drift and a hammer to prevent damage and/or distortion of parts.

(2) Inspect planet pinions, sun gear, and ring gear for wear and damage. Replace gears that are scored, pitted, ridged, or worn.

(3) Inspect planet carrier assembly for pitted, worn or scored thrust washers, worn or ridged planet pinion shafts and worn, scored or ridged planet pinions.

(4) Inspect axle shafts for signs of torsional fractures or other indications of impending failure.

Note. If equipment is available, perform magnetic inspection and dye penetrant tests.

(5) Inspect studs for tightness. Check machined areas for nicks, mars or burs. Clean all threads and chase if necessary.

(6) Check all parts against tolerances listed in table 1–1. Replace all parts not conforming to tolerances in repair and replacement standards.

f. Reassembly.

(1) Install plug (42, fig. 7–2). Replace all gaskets and preformed packings. Replace all oil seals that are worn, damaged, or show signs of drying out.

(2) Carefully slide spindle (39) over axle (41). Attach brake shoe assembly (40) to spindle with screws (36), washers (37) and nuts (38).

(3) Attach brake drum (28) to hub assembly (29) with screws (35). Install oil slinger (33) and bearing cone (32). Slide brake drum and hub assembly over brake shoe assembly. Install bearing cup (29).

(4) If removed for replacement, press in sleeve bearing (26). Install bearing cup (24) and cone (23). Install locking plates (22) with screws (21). Install hub assembly (25), ring gear (20), retaining nut (19), retainers (18), thrust washer (17), sun gear (16), and retaining ring (15).

(5) Install planet pinions (12) into planet carrier (9) using planet pinion shafts (11) and thrust washers (13 and 14).

Note. Press in planet pinion shafts until shoulder of shaft butts the thrust washer.

g. Installation.

(1) Install preformed packing (10, fig. 7–2). Install planet carrier assembly (9) on studs (8) with washers (7) and nuts (6).

(2) Install plugs (3 and 4) in cover (2). Install cover with screws (1). Use a new gasket (5).

(3) Refer to TM 5–3805–239–12 and install wheels and tires.

Section III. DIFFERENTIAL ASSEMBLY

7–5. General

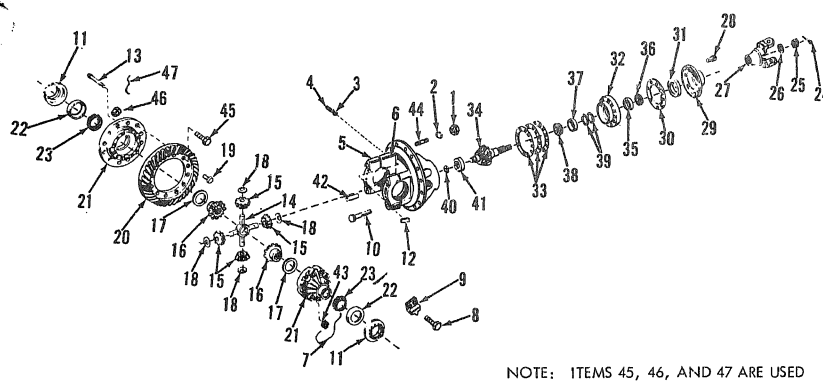
a. The differential transmits driving power to the vehicle wheels and compensates for differences in relative turning speeds. The differential is a limited-slip type. It transmits reduced torque to a slipping wheel to prevent unnecessary spinning and reduce loss of traction under adverse operating conditions.

b. Repair instructions for the axle differentials apply to both front and rear axles with the differences noted in the text and on the illustration.

7–6. Differential Assembly

a. General. The differential transmits engine driving torque to both wheels at all times. A limited-slip feature transmits increasing driving effort to the wheel with the best traction and reduces torque delivered to a slipping wheel to prevent or reduce tendency to spin. Traction is improved by this means and the vehicle is able to negotiate adverse or difficult terrain with greater ease and safety.

b. Removal. Refer to paragraph 2–32 and remove axle from loader.



NOTE: ITEMS 45, 46, AND 47 ARE USED ON REAR AXLE ONLY. ITEM 19 IS USED ON FRONT AXLE ONLY.

1 Nut, 1/2 in. NF (14 rqr)
2 Washer, lock, 1/2 in. (14 rqr)
3 Nut, self-locking
4 Screw, slotted head
5 Bearing cap (2 rqr)
6 Differential carrier
7 Lock wire
8 Screw, cap, hex-head (4 rqr)
9 Lock plate (2 rqr)
10 Screw, cap, hex-head (4 rqr)
11 Ring, adjusting
12 Thrust block
13 Screw, cap, hex-head (8 rqr)
14 Pinion carrier
15 Pinion (4 rqr)
16 Bevel gear (2 rqr)
17 Washer, thrust (2 rqr)
18 Washer, thrust (4 rqr)
19 Rivet (12 rqr)
20 Ring gear
21 Case
22 Bearing cup (2 rqr)
23 Bearing cone (2 rqr)
24 Pin, cotter
25 Nut, castellated
26 Washer, flat
27 Flange
28 Screw, cap, hex-head (8 rqr)
29 Cover
30 Gasket
31 Oil seal
32 Retainer assembly
33 Shim pack
34 Pinion gear assembly
35 Bearing cup
36 Bearing cone, outer
37 Bearing cup
38 Bearing cone, inner
39 Spacer (5 rqr)
40 Ring, retaining
41 Bearing
42 Pin, dowel (4 rqr)
43 Nut, castellated
44 Stud (14 rqr)
45 Screw, cap, hex-head, 1/2 x 1-3/4 in. (12 rqr)
46 Nut, 1/2 in. (12 rqr)
47 Lock wire

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Figure 7-3. Differential assembly, exploded view.

(1) If not already done, drain lubricant from axle housing. Remove planetary hubs as outlined in paragraph 7-4.

(2) Refer to TM 5-3805-239-12 and remove wheels and tires.

(3) Disconnect universal joint flange (27,

fig. 7–3). Remove 14 nuts (1) and lock washers (2).

Note. Loosen two top nuts and leave on studs to prevent carrier from falling out of axle.

(4) Using a suitable tool, break carrier from housing. Remove top nuts and work carrier free by using puller screws in holes provided.

(5) Place carrier on a suitable stand or holding fixture.

Note. If initial inspection indicates that the drive gear (20) is not going to be replaced, measure and record backlash for reference during reassembly procedure.

(6) Loosen nut (3) and back off screw (4). Center punch one bearing cup (5) and differential carrier (6) to assure correct reassembly.

(7) Cut lock wire (7) and remove screws (8) and lock plate (9). Remove screws (10), bearing caps (5), and adjusting rings (11).

(8) Carefully lift out differential and gear assembly. Remove thrust block (12), screw (4) and nut (3).

c. Disassembly.

(1) Punch mark differential case halves for reference during reassembly.

(2) Cut lockwire and remove eight screws (13, fig. 7–3) and nuts (43). Separate differential case halves.

(3) Remove pinion carrier (14), pinions (15), bevel gears (16) and thrust washers (17 and 18). If necessary, remove 12 rivets (19) and separate ring gear (20) and case (21).

Note. To remove rivets, center punch in center of head and drill through head using a drill 1/32 inch smaller than body of rivet. Press out rivets.

(4) If necessary, remove bearing cup (22) and cone (23) using a suitable puller.

Note. Screw (45), nut (46) and lockwire (47) are used on rear axle only and replace rivet (19) used on front axle only.

(5) Remove cotter pin (24), castellated nut (25) and washer (26). Remove flange (27) using a suitable puller.

Caution: **Driving the flange off will cause runout.**

(6) Remove eight screws (28), cover (29), gasket (30) and oil seal (31). Remove retainer assembly (32) using puller screws in the holes provided.

Caution: **Attempts to use a pinch bar will damage the shims. Driving pinion from inner end with a drift will damage the bearing lock ring groove.**

(7) Tap pinion gear assembly (34) out of retainer (32) with a soft mallet, or press shaft from cage.

Note. Wire shim pack (33) together on removal to facilitate adjusting during reassembly.

(8) Remove outer bearing cup (35) and cone (36) and inner bearing cup (37) and cone (38) from retainer. Remove spacers (39) from pinion shaft. Remove retaining ring (40) and bearing (41).

d. Cleaning.

(1) Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

(2) Coat all metal parts that are to be reused with a thin film of engine oil (OE).

e. Inspection and Repair.

(1) Inspect all bearing cups and cones, including those not removed from the differential carrier. Replace any that are worn, pitted or damaged in any way.

(2) Inspect gears for wear and damage. Gears which are worn, ridged, pitted or scored require replacement, both gears must be reshould be replaced. If the pinion or ring gear placed as a set.

(3) Inspect the differential case halves, the thrust washers, the pinion carrier and the bevel gears for pits, scores, and excessive wear.

Note. Thrust washers must be replaced in sets. Premature failure will occur if old and new washers are installed together.

(4) Inspect differential pinions and teeth of bevel gears for any damage or wear. Defective differential pinions and bevel gears must be replaced in sets.

(5) Check all studs for tightness and stripped or damaged threads. Inspect machined or ground surfaces for nicks, mars or burs.

(6) Replace all oil seals and gaskets. If bearings require replacement, replace bearing and bearing cup as a set.

f. Reassembly.

(1) Install bearing (41, fig. 7–3) on pinion gear assembly (34) and secure with retaining ring (40). Install bearing (38) tight against pinion gear. Press on bearing cup (37).

(2) Install spacers (39), lubricate bearing and install retainer assembly (32). Install bearing (36) against spacers.

Note. Do not install retainer assembly screws at this time.

(3) Rotate retainer assembly several times to assure normal bearing contact. Install flange (27), washer (26), and nut (25). Hold flange firmly and tighten nut to 1000 foot-pounds. Wrap a length of soft wire or string around the retainer assembly and check pinion preload torque with a pull scale. The rotating torque (not starting torque) should be 5 to 15 pounds. If torque is not within this range, remove retainer assembly (32) and bearing (36), and install a thinner (or thicker) spacer (39) between the bearings. A thinner spacer will increase bearing preload and a thicker spacer will decrease bearing preload.

Caution: **If spacer is changed, be certain to retorque nut (25) to proper torque before rechecking preload.**

(4) After obtaining correct preload, remove flange (27), washer (26) and nut (25). Coat flange of cover (29) with an approved non-hardening (Permatex) sealing compound and press cover and gasket (30) firmly onto retainer assembly (32).

(5) Install original shim pack (33) and install two screws (28) as guides.

Note. Locate thin shims in shim pack on both sides for maximum sealing ability.

(6) Gently tap pinion gear assembly (34) into position using a soft mallet. Install remaining screws (28) but do not tighten securely at this time.

(7) Install flange, washer, and nut and torque nut to 1,000 foot-pounds. Install cotter pin (24).

Note. Do not back off the nut to align cotter pin hole.

(8) If previously removed, rivet ring gear (20) to case half (21) using new rivets (19).

Note. Rivets should not be heated. Use cold annealed steel rivets. Correctly formed rivet heads will be at least ⅛ inch larger than the diameter of the rivet hole. Excessive pressure while setting rivets will cause distortion of the case holes and may result in gear eccentricity.

(9) Lubricate inside of differential case and all other differential parts with approved axle lubricant (GO). Install thrust washers (17 and 18), bevel gears (16) and pinions (15) on pinion carrier (14) and in differential case (21). Aline match marks on differential case halves and draw halves together with four screws (13) and nuts (43).

Note. Screw (45), nut (46) and lock wire (47) are used on rear axle only and replace rivet (19) used on front axle only.

(10) Check for free rotation of the differential gears. If there is no binding, install remainder of screws (13) and nuts (43) and tighten to 130–145 foot-pounds and install lock wires (7).

(11) Press bearings (23) squarely and firmly on differential case. Temporarily in stall bearing cups (22), adjusting rings (11), and bearing caps (5). Install screws (10) and tighten evenly to 290 to 320 foot-pounds .

Note. Bearing cups must be a hand push fit in their respective bores. Use a bearing scraper or emery cloth if necessary to secure correct fit. Check work progress frequently with bearing cup to avoid a loose fit.

(12) Remove bearings caps (5), adjusting rings (11), and bearing cups (22). Pack bearings and cups with approved fiber base grease (WB) and install differential assembly into carrier.

(13) Insert adjusting rings (11) and tighten hand tight against the differential bearing cups. Install bearing caps (5) and tap them into position.

Caution: **Do not force bearing caps since this will ruin the carrier housing or the bearing caps. If bearing caps do not position properly, adjusting rings may be cross threaded. Remove caps and reposition adjusting rings.**

(14) Install a dial indicator on the back face of the ring gear (20). Loosen adjusting rings (11) until end play is noted on indicator. Alternately tighten adjusting rings for 0.0000 inch end play. Check ring gear run out.

Note. Ring gear run out should not exceed 0.0080 inch.

(15) Using two bars, tighten each adjusting ring one notch each from the 0.0000 inch end play point to preload the differential bear ings. Tighten screws (10) to 290 to 320 foot-pounds torque.

(16) Install a dial indicator on face of one of the ring gear teeth. Move ring by hand and note reading on indicator.

Note. Correct backlash for new gears should be 0.0060 to 0.0120 inch. If backlash exceeds 0.0120 inch adjust the ring gear only by backing off one of the adjusting rings (11) and advancing the opposite adjusting ring by the same amount.

(17) Check for proper tooth contact between pinion teeth and ring gear by applying oiled red lead to approximately 12 teeth of the

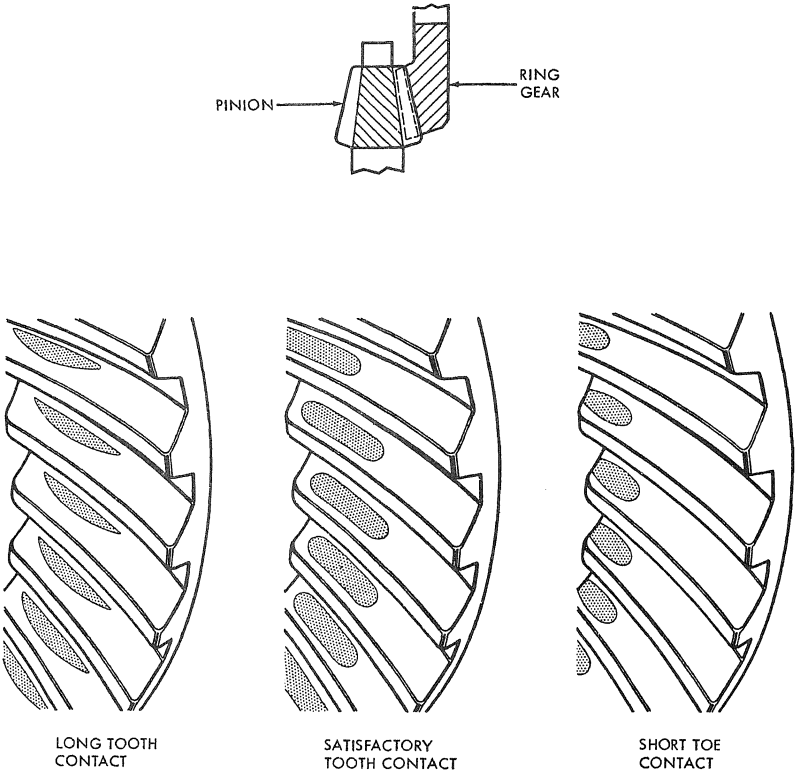


Figure 7–4. Gear teeth contact patterns.

ring gear (20) and rotating the pinion gear. The red lead on the ring gear teeth will be squeezed by contact with the pinion gear teeth, leaving bare areas showing the exact size. shape and location of the contact.

(18) See figure 7–4. The area of contact on the drive side must favor the toe of the gear tooth, should extend ½ to ⅔ of the tooth length toward the heel, and be centered between the top and bottom of the tooth.

Note. The area of contact on the coast side will appear as indicated above; however, the bared area will be centered between the toe and heel of the tooth.

(19) A low contact (fig. 7 –4) indicates the pinion is in too deep. Set the pinion to the correct depth by adding shims (33) under the retainer assembly (32). The ring gear may require slight inward movement to maintain correct backlash.

(20) A high contact indicates pinion is too far out. Set the pinion to the correct depth by removing shims under the retainer assembly. The ring gear may require slight outward movement to maintain correct backlash.

(21) After obtaining satisfactory tooth contact (fig. 7–4) backlash may be adjusted from 0.0050 to 0.0150 inch to correct for short or long toe contact. A high backlash setting can be used to correct short toe contact. A low backlash setting can be used to keep the contact from starting too far away from the toe.

(22) After establishing correct tooth contact, install lock plates (9, fig. 7–3) and screws (8) and tighten securely. Install lock wires (7).

(23) Remove carrier assembly from stand and position so that the thrust adjustment hole faces upward. Place thrust block (12) on rear face of ring gear (20) and rotate gear until hole in thrust block is aligned with hole in carrier assembly.

(24) Install screw (4) and nut (3). Tighten screw securely, then back off ¼ turn and lock securely with nut. Clearance should be 0.0100 to 0.0150 inch. Check for minimum 0.1000 inch clearance during full rotation of ring gear.

g. Installation.

(1) Using a suitable hoist and sling attached to the pinion shaft, position the differential assembly into the axle housing.

(2) Install nuts (1, fig. 7–3) and lock washers (2) on studs (44). Tighten four equally spaced nuts to draw carrier squarely into the housing.

(3) Install remaining nuts and lock washers and tighten to 92 to 103 foot-pounds torque.

(4) Install axle assembly as outlined in paragraph 2–32.

(5) Refer to TM 5–3805–239–12 and install wheels and tires.

Section IV. AXLE HOUSINGS

7–7. General

a. Support for the axles, planetaries, and differential assemblies is provided by the cast steel axle housings. Flanges on each end of the housing support the planetary hubs and brakes.

b. The front and rear axles are basically the same and disassembly is quite similar. Figures 7–5 and 7–6 show both axles.

7–8. Axle Housings

a. Removal.

(1) Refer to paragraph 2–32 and remove the axles from the loader.

(2) Refer to paragraphs 7–4 and 7–6 and remove planetary hubs and differential assembly from the axles.

Note. Disassemble axle assemblies only far enough to perform the repair functions required.

b. Disassembly.

(1) *Rear axle.*

(*a*) Remove drain and fill plugs (1 and 2, fig. 7–5) from axle housing (11).

(*b*) Remove breather (3) from housing.

(*c*) Inspect studs (7 and 8). If studs are damaged and require replacement, remove studs from housing.

(*d*) Inspect bearings (9) and spacer (10). If bearings and spacer are worn or damaged, press bearings and spacers from axle using a suitable press.

(2) *Front axle.*

(*a*) Remove drain and fill plugs (1 and 2, fig. 7–6) from axle housing (13).

(*b*) Remove breather (3) from housing.

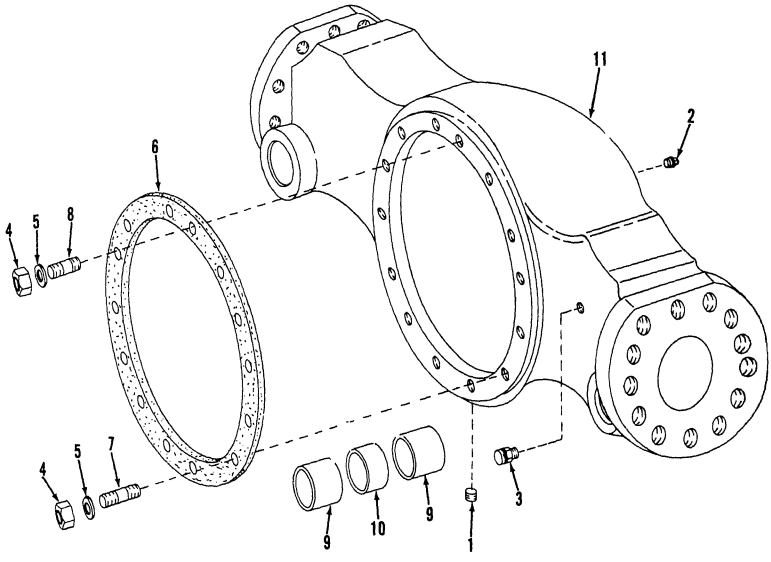
(*c*) Inspect studs (7, 8, and 9). If studs are damaged and require replacement, remove studs from housing.

(*d*) Inspect bearings (11) and spacers (12). If bearings and spacers are worn or damaged, press bearings and spacers from housing using a suitable press.

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

d. Inspection and Repair.

(1) Inspect studs for secure fit in housing and for damaged threads and cracked or broken studs. Replace damaged studs.



1 Drain plug
2 Fill plug
3 Breather
4 Nut, self-locking (14 rqr)
5 Washer, flat (14 rqr)
6 Differential carrier gasket
7 Stud, long (4 rqr)
8 Stud, short (10 rqr)
9 Sleeve bearing (4 rqr)
10 Spacer (2 rqr)
11 Axle housing

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Figure 7–5. Rear axle housing, exploded view.

(2) Inspect sleeve bearings for wear and damage. Replace worn or damaged bearings.

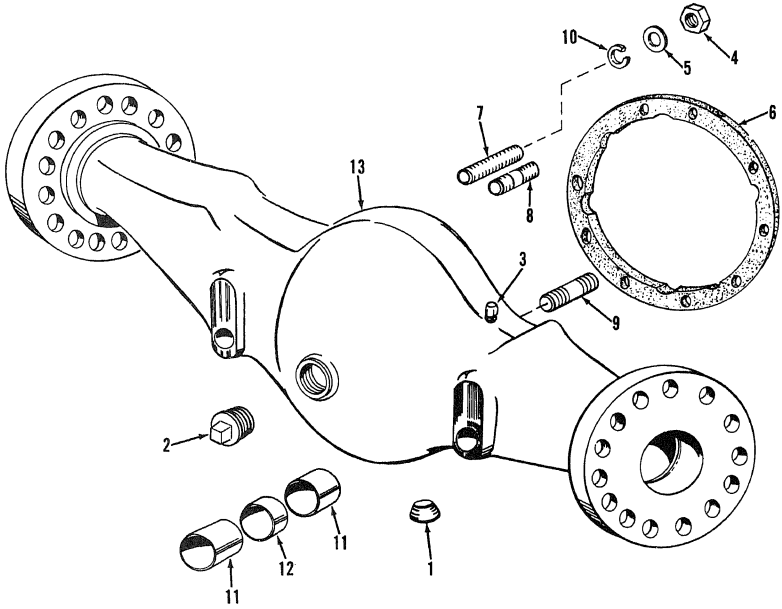
(3) Inspect axle housings for cracks and damage. Check wheel flanges for cracks. Inspect all threaded hole for damage to threads. Repair threads with a thread chaser if possible. Replace damaged or unserviceable housings.

e. Reassembly.

(1) *Rear axle.*

(*a*) If sleeve bearings (9, fig. 7–5) and spacers (10) were removed, press bearings and spacers into bores in housing (11).

(*b*) If studs (7 and 8) were removed install studs in housing, using a suitable stud driver.



1 Drain plug
2 Fill plug
3 Breather
4 Nut, self-locking (14 rqr)
5 Washer, flat (14 rqr)
6 Differential carrier gasket
7 Stud, long (2 rqr)
8 Stud, short (8 rqr)
9 Stud, housing (4 rqr)
10 Washer, lock (14 rqr)
11 Sleeve bearing (4 rqr)
12 Spacer (2 rqr)
13 Axle housing

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Figure 7–6. Front axle housing, exploded view.

(*c*) Install plugs (1 and 2) and breather (3) in housing.

(2) *Front axle.*

(*a*) If bearings (11, fig. 7–6) and spacers (12) were removed, press bearings and spacers into bores in housing (13).

(*b*) If studs (7, 8, and 9) were removed, install studs in housing, using a suitable stud driver.

(*c*) Install plugs (1 and 2) and breather (3) in axle.

f. Installation.

(1) Refer to paragraphs 7–4 and 7–6 and install the differential assembly and planetary hubs on the axle.

(2) Refer to paragraph 2–32 and install the axles on the loader.

CHAPTER 8

AIR SYSTEM AND BRAKES REPAIR INSTRUCTIONS

Section I. GENERAL

8–1. Description

a. The air system of the loader supplies air pressure to operate the wheel brakes and the air horn. Pressure is supplied by an air compressor (fig. 8–1) which is driven by a belt from the engine crankshaft. Air from the compressor is stored in an air reservoir (fig. 8–1) mounted below the platform on the right side of the loader.

b. Air lines deliver the air to the dual brake application valve (fig. 8–1). When either brake pedal is depressed air is delivered to the front and rear power clusters (fig. 8–1). The air pressure in the power clusters actuates a brake master cylinder, producing hydraulic pressure in the cylinder. This pressure is delivered to the four brake cylinders (fig. 8–1) mounted in the wheel brakes. The wheel brake cylinders apply the wheel brakes.

8–2. Operation

a. Whenever the engine is operating the air compressor is running. As air pressure builds up in the air reservoir, the compressor continues to deliver air to the reservoir. When the pressure has built up to the maximum setting of the governor (fig. 8–1) the air is bypassed from one cylinder to another in the compressor by unloading action of the valves.

b. Depressing of either brake pedal by the operator allows air to flow from the dual application valve to the power clusters, actuating the hydraulic system and applying the brakes. A portion of the hydraulic oil is also delivered from the front power cluster (fig. 8–1) to the clutch cut-off valve. If the valve has been opened by the operator the hydraulic oil goes to the clutch cut-off on the transmission. The clutch cut-off disengages the transmission drive train and halts the power from the transmission to the axles. This allows the operator to shift, change direction or operate the hydraulic system without the loader moving. Upon release of the brake pedal the transmission and drive train return to operation and again propel the loader in the direction desired.

Section II. AIR COMPRESSOR

8–3. General

a. The air compressor is mounted on the right side of the engine outside of the thermostat housing. Drive to the compressor pulley is supplied by a belt from the engine crankshaft.

b. The compressor is cooled by coolant delivered to the cylinder head by a hose from the thermostat housing. Lubrication is supplied through an external oil line extending from the main oil gallery of the engine to the rear cover of the compressor. An external oil line returns the oil to the engine from the compressor crankcase.

8–4. Air Compressor

a. Removal. Refer to TM 5–3805–239–12 and remove the air compressor.

(1) Remove four screws (43, fig. 8–2) and lock washers (44), and remove compressor bracket (45) and gasket (46) from engine.

(2) Remove two screws (34) and lock washers (35) and remove governor (36) and gasket (37) from compressor.

(3) Remove two screws (19) and lock washers (20) and remove air inlet elbow (21) and gasket (22) from compressor.

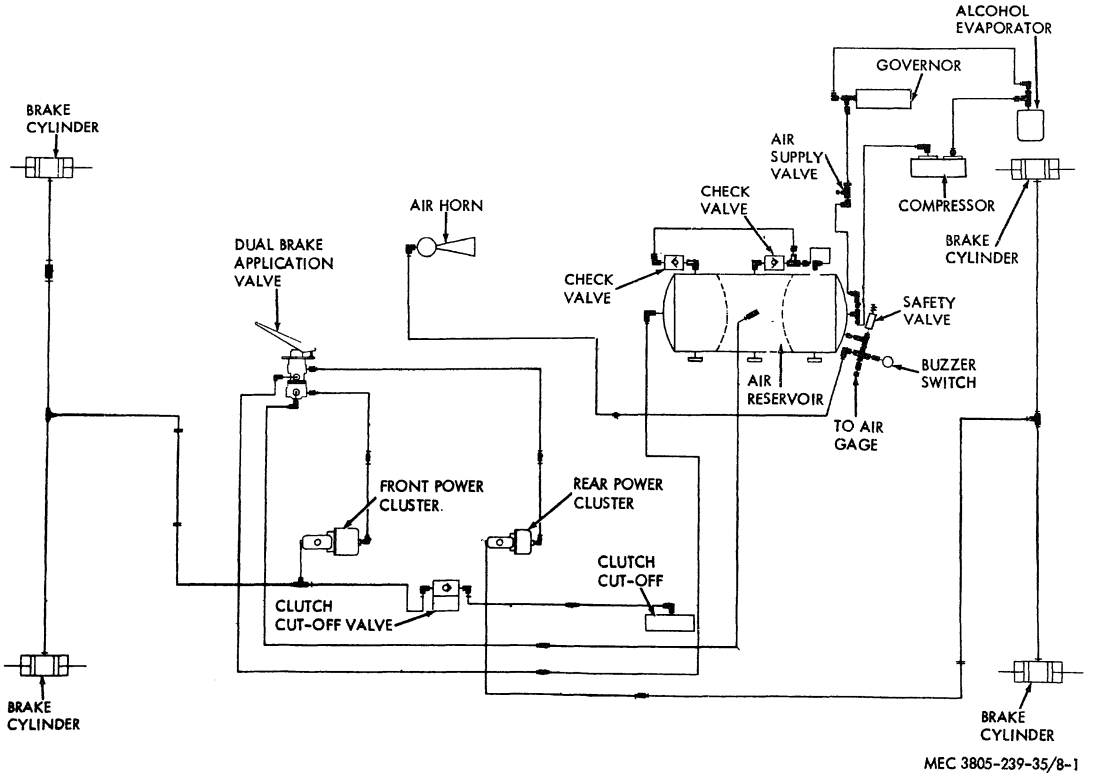
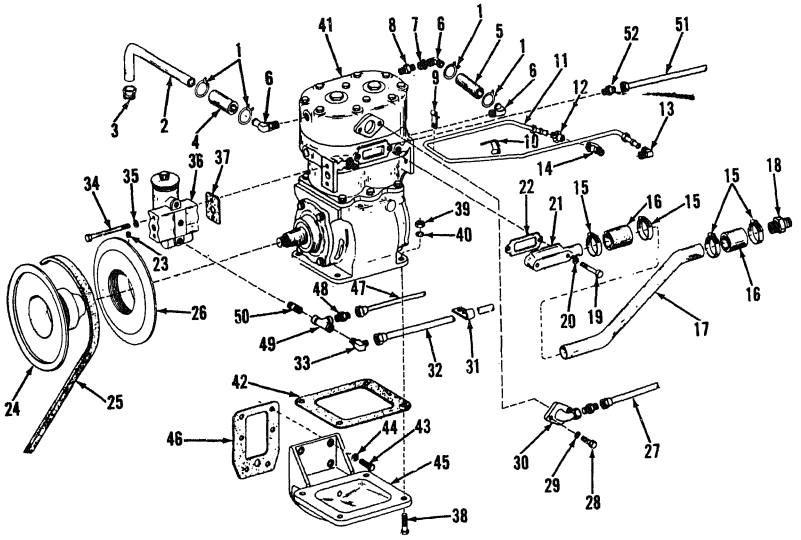


Figure 8-1. ...ystem, schematic view.

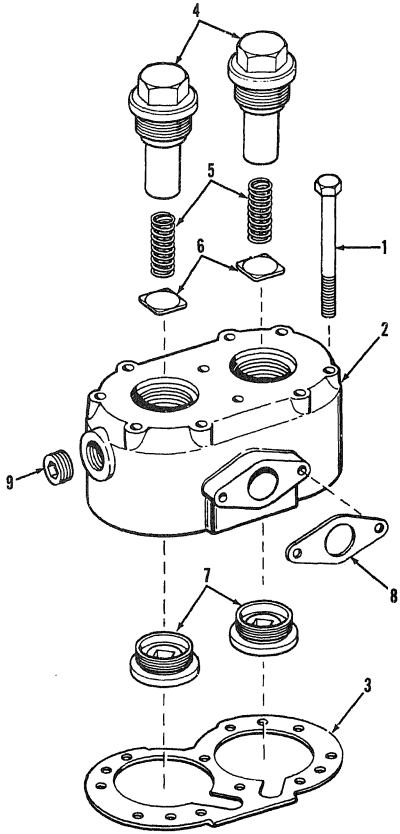


1 Hose clamp (4)
2 Water outlet tube
3 Tube nut
4 Hose
5 Water inlet hose
6 Elbow (3)
7 Pipe bushing
8 Adapter
9 Tube clamp
10 Tube clamp
11 Oil tube assembly
12 Adapter
13 Elbow
14 Elbow
15 Hose clamp (4)
16 Hose (2)
17 Air inlet tube
18 Nipple
19 Screw, cap, hex-head, $^{5}/_{16}$–18 x 2 in. (2)
20 Washer, lock, $^{7}/_{16}$ in. (2)
21 Air inlet elbow
22 Gasket
23 Setscrew, $^{3}/_{8}$–16 x $^{1}/_{2}$ in. (3)
24 Pulley half
25 Drive belt
26 Pulley half
27 Hose, compressor to reservoir
28 Screw, cap, hex-head, $^{5}/_{16}$–18 x $^{7}/_{8}$ in. (2)
29 Washer, lock, $^{5}/_{16}$ in. (2)
30 Adapter, hose
31 Clamp
32 Tube, alcohol evaporator to governor
33 Elbow
34 Screw, cap, hex-head, $^{5}/_{16}$–18 (2)
35 Washer, lock, $^{5}/_{16}$ in. (2)
36 Governor
37 Governor gasket
38 Screw, cap, hex-head, $^{7}/_{16}$–14 x 1$^{3}/_{4}$ in. (4)
39 Nut, $^{7}/_{16}$–14 (4)
40 Washer, lock, $^{7}/_{16}$ in. (4)
41 Compressor
42 Compressor gasket
43 Screw, cap, hex-head, $^{7}/_{16}$–18 x 1$^{1}/_{8}$ in. (4)
44 Washer, lock, $^{7}/_{16}$ in. (4)
45 Compressor bracket
46 Gasket
47 Hose, governor to supply valve
48 Adapter
49 Tee
50 Nipple
51 Tube, compressor to alcohol evaporator
52 Adapter

Figure 8–2. Compressor, governor, and bracket, exploded view.

c. Disassembly. Clean the exterior of the compressor with cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air. Scribe marks on cylinder head, block, and crankcase for alinement of parts reassembly.

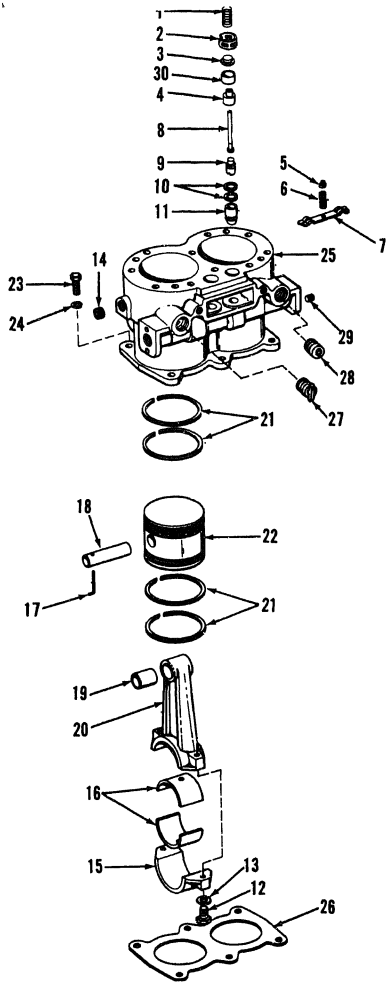
(1) Remove eight screws (1, fig. 8–3) a remove cylinder head (2) and gasket (3).



1 Screw, cap, hex-head (8 rqr)
2 Cylinder head
3 Gasket
4 Valve cap nut (2 rqr)
5 Valve spring (2 rqr)
6 Discharge valve (2 rqr)
7 Valve seat (2 rqr)
8 Gasket
9 Pipe plug (2 rqr)

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Figure 8–3. Air compressor cylinder head, exploded view.



1 Inlet valve spring (2 rqr)
2 Inlet valve guide (2 rqr)
3 Inlet valve (2 rqr)
4 Inlet valve seat (2 rqr)
5 Unloader spring seat
6 Unloader spring
7 Unloader saddle
8 Unloader plunger (2 rqr)
9 Unloader piston (2 rqr)
10 Grommet (2 rqr)
11 Unloader cup (2 rqr)
12 Screw, cap, hex-head (4 rqr)
13 Washer, lock (4 rqr)
14 Pipe plug
15 Connecting rod cap (2 rqr)
16 Connecting rod bearings (2 rqr)
17 Lock wire (2 rqr)
18 Piston pin (2 rqr)
19 Bearing (2 rqr)
20 Connecting rod (2 rqr)
21 Piston ring (8 rqr)
22 Piston (2 rqr)
23 Screw, cap, hex-head (6 rqr)
24 Washer, lock (6 rqr)
25 Cylinder block
26 Gasket
27 Drain cock
28 Pipe plug
29 Pipe plug
30 Bearing (2 rqr)

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Figure 8–4. Cylinder block and pistons, exploded view.

(2) Remove two valve cap nuts (4), springs (5), and valves (6). Inspect valve seats (7) and remove if worn or damaged.

(3) Remove gasket (8) and pipe plug (9).

(4) Remove two inlet valve springs (1, fig. 8-4), guides (2), and valves (3) from cylinder block (25).

(5) Remove unloader spring seat (5), spring (6), and saddle (7). Remove plunger (8), piston (9), and piston grommets (10). Remove unloader cup (11).

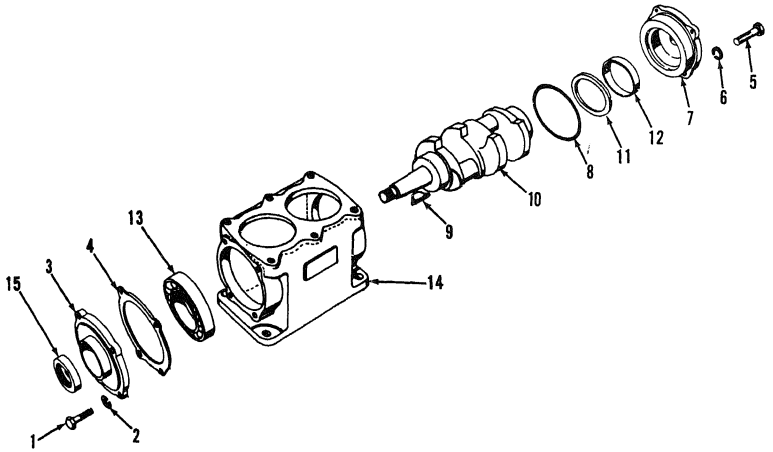
(6) Remove four screws (12) and lock washers (13). Remove bearing caps (15) and bearings (16). Push piston and connecting rod assemblies out through top of cylinder block. Install bearing caps and connecting rods to keep parts as an assembly.

(7) Remove lock wire (17) and piston pins (18) from pistons (22) and connecting rods (20). Remove rods from pistons. If bearing (19) requires replacement, press bearing from connecting rod.

(8) Using a piston ring pliers, remove piston rings (21) from piston.

(9) Remove six screws (23) and lock washers (24) and remove cylinder block from crankcase. Remove gasket (26).

(10) Mark drive end of crankcase with a scribe mark. Remove eight screws (1 and 5, fig.



1 Screw, cap, hex-head (4 rqr)
2 Washer, lock (4 rqr)
3 Cover
4 Gasket
5 Screw, cap, hex-head (4 rqr)
6 Washer, lock
7 Cover
8 Grommet
9 Key
10 Crankshaft
11 Thrust washer
12 Bearing
13 Bearing
14 Crankcase
15 Oil seal

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Figure 8-5. Crankcase and crankshaft, exploded view.

and lock washers (2 and 6) and remove covers (3 and 7) from crankcase. Remove gasket (4) and grommet (8).

(11) Remove crankshaft (10) from crankcase. Remove bearing (13) from crankcase.

(12) Remove thrust washer (11). Inspect bearing (12) and remove bearing if replacement is necessary.

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

d. Inspection and Repair.

(1) Inspect cylinder head for cracks and warpage. Test water passages in cylinder head with compressed air to check for leaks. Replace cracked, warped, or leaking cylinder heads.

(2) Inspect discharge valves for wear and for grooves where valves contact seats. If grooves are 0.0030 inch or more replace valves.

(3) Inspect discharge valve seats for wear and damage. Replace seats if worn or damaged.

Note. Valve seats may be lapped to reface the seat if sufficient metal remains after lapping.

(4) Inspect cylinder block as follows:

(*a*) Inspect cylinder bores for wear and scoring.

(*b*) Measure inside diameter of cylinder bores with an inside micrometer for roundness. Bores should be round with 0.0020 inch. Taper of bore should not exceed 0.0030 inch.

(*c*) If possible, finish bore and hone cylinders that do not meet tolerances described above. Machine cylinders with cylinder block secured to crankcase.

(5) Inspect unloader pistons for wear and scoring. Replace scored or worn pistons.

(6) Inspect inlet valves for grooves. If grooves are deeper than 0.0030 inch, replace valves.

(7) Inspect inlet valve seats for wear. Reface valve seats, if possible. Replace badly worn seats.

(*a*) To remove valve seat, drill and tap a 5/8 inch hole in seat. Use a puller adapter and slide hammer and remove valve seat.

(*b*) Use an old inlet valve as a driver and press the new valve seat into bore in cylinder head. Seat should not extend above cylinder head in excess of 0.1450 inch. New seats should extend 0.1030 to 0.1130 inch.

(8) Inspect piston for cracks, scoring, and wear. Replace cracked, scored, or worn pistons.

(*a*) Measure outer diameter of piston. Clearance between piston (without rings) and cylinder bore should be 0.0020 to 0.0040 inch.

(*b*) Check fit of piston pin in connecting rod bearing. Clearance should be 0.0001 to 0.0006 inch and should not exceed 0.0015 inch.

(*c*) Install piston rings in cylinder in which they will be used. Push rings down into piston travel area. Measure gap between ends of rings. Gap should be 0.0070 to 0.0190 inch.

(*d*) Slide edge of rings into grooves on piston and measure clearance between ring and groove. Clearance should be 0.0015 to 0.0030 inch.

(9) Inspect connecting rod bearings for wear, cracks, and chipping. Replace worn, cracked, or chipped bearings.

(10) Clearance between connecting rod bearing and crankshaft journal should be 0.0003 to 0.0021 inch.

(11) Check crankshaft journals for out of round condition. Replace crankshaft if journal exceeds 0.0002 inch out of round.

(12) Inspect crankshaft main bearings for wear and flat spots. Replace bearing if worn or unserviceable.

(13) Inspect bearing bores in crankcase. Bearings must be a finger press fit in bores. If bearings are loose in bores, replace bearings and/or crankcase.

(14) Check all parts against tolerances listed in table 1–1. Replace all parts not conforming to repair and replacement standards.

e. Reassembly.

(1) Install bearing (13, fig. 8–5) in bore in crankcase (14). Install new oil seal (15), with sealing toward inside of cover, in cover (3). Install bearing (12) in cover (7).

(2) Install crankshaft (10) in crankcase with drive end of crankshaft extending from same end of crankcase as before disassembly.

(3) Install cover (3) and new gasket (4) on crankcase and secure with four screws (1) and lock washers (2). Install thrust washer (11) on crankshaft. Install cover (7) and new grommet (8) and secure with four screws (5) and lock washers (6).

(4) Using a piston ring pliers install piston rings (21, fig. 8–4) on piston (22) with level or punch mark on ring toward the top. Stagger ring gaps around piston.

(5) Install connecting rod (20) in piston

and install piston pin (18) through rod and piston. Secure pin with locking wire (17).

(6) Install drain cock (27) and plugs (14, 28, and 29) in cylinder block (25). Install cylinder block, with scribe marks alined, with a new gasket (26) on the crankcase. Install six screws (23) and lock washers (24).

(7) Remove connecting rod cap (15) from connecting rod. Apply engine oil (OE) to piston rings and piston. Use a piston ring compressor and install piston and connecting rod assembly through top of crankcase bore.

(8) Lubricate connecting rod bearings (16) with engine oil (OE) and install bearings and cap (15) on crankshaft. Install two screws (12) and lock washers (13) to secure caps to connecting rod. Do not overtighten screws.

(9) Install second piston and connecting rod in the same manner.

(10) Lubricate bores in block and unloader cups (11) and grommets (10) with engine oil (OE). Install unloader cups and grommets in cylinder block. Install unloader piston (9) and plunger (8).

(11) Install unloader saddle (7), spring (6) and unloader spring seat (5).

(12) Connect an air line to the governor line port and apply 100 psi air pressure. Coat unloader pistons (9) with soap suds and observe for air bubbles. Leakage should not exceed a ½ inch soap bubble within not less than 5 seconds. Remove air line and clean soap from valves and dry thoroughly.

(13) Install valve seats (4). Install inlet valve guides (2), valves (3), and valve springs (1) on valve seats.

(14) Install discharge valve seats (7, fig. 8–3). Install discharge valves (6) and springs (5) in cylinder head (2). Install cap nuts (4). Install plug (9) in cylinder head.

(15) Check travel of discharge valves. Travel should be 0.0360 to 0.0580 inch. Connect an air line to the discharge port of the cylinder head. Apply 100 psi air pressure to cylinder head. Coat discharge valve openings in cylinder head with soap suds. Leakage should not exceed a one inch soap bubble in not less than 5 seconds. If excess leakage is found, continue to apply air pressure and tap discharge valves (6) off their seats, using a wooden dowel and a light hammer. Repeat this several times to allow valves to seat properly and improve the seal on their seats. Check with soap suds around cap nuts (4) with air pressure applied. There should be no leakage at cap nuts. Disconnect air line and clean soap suds from cylinder head.

(16) Install cylinder head (2) and new gasket (3), on cylinder block, with scribe marks alined. Aline inlet valve springs with counterbores in cylinder head when installing head.

(17) Secure cylinder head with eight screws (1). Tighten screws securely.

f. Installation.

(1) Install air inlet elbow (21, fig. 8–2) and gasket (22) on air compressor and secure with two screws (19) and lock washers (20).

(2) Install governor (36) and gasket (37) on compressor and secure with two screws (34) and lock washers (35).

(3) Install compressor bracket (45) and gasket (46) on engine and secure with four screws (43) and lock washers (44).

(4) Refer to TM 5–3805–239–12 and install air compressor on engine.

Section III. AIR SYSTEM GOVERNOR

8–5. General

a. The air compressor runs continuously when the engine is operating. Compression of the air is controlled by the governor (fig. 8–1). The governor controls the air supply by unloading the compressor when pressure in the air reservoir reaches maximum setting of the governor. The governor is set to operate at 90 to 105 psi.

b. When the pressure in the air reservoir is reduced to the minimum setting of the governor, the governor valve closes. The compressor unloader piston return spring forces the unloader piston down, closing the port and releasing the inlet valve springs. The inlet valves return to their seats and compression is resumed.

8–6. Air Compressor Governor

a. Removal.

(1) Open drain cocks at air reservoir and drain air pressure from system.

(2) Disconnect alcohol evaporator to governor tube (32, fig. 8–2) from elbow (33).

(3) Disconnect governor to supply valve base (47) from adapter (48).

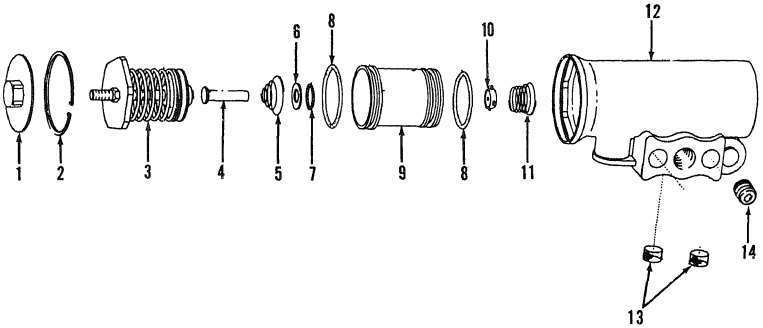
(4) Remove elbow (33), adapter (48), tee (49), and nipple (50) from governor.

(5) Remove two screws (34) and lock washers (35) and remove governor (36) and gasket (37) from air compressor (41).

b. Disassembly. Clean exterior of governor with cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

(1) Remove cover (1, fig. 8–6) from governor. Remove retaining ring (2) and remove adjusting screw assembly (3).

Note. Do not disassemble or change setting of adjusting screw assembly.



1 Cover
2 Ring, retaining
3 Adjusting screw assembly
4 Exhaust stem
5 Stem spring
6 Piston washer
7 Packing, preformed
8 Packing, preformed (2 rqr)
9 Piston
10 Governor valve
11 Valve spring
12 Body
13 Filter (2 rqr)
14 Plug (3 rqr)

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Figure 8–6. Air compressor governor, exploded view.

(2) Remove exhaust stem (4) and spring (5).

(3) Remove piston (9) and remove outer packings (8) from piston. Do not remove washer (6) or inner packing (7) unless packing requires replacement.

(4) Remove plugs (14) from body. Do not remove filters (13) unless they require replacement.

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air. Clean all body passages with a probe made of brass wire.

d. Inspection and Repair.

(1) Inspect valve for wear and damage. Inspect valve seat for wear. Replace valve if worn or damaged.

(2) Inspect exhaust stem for wear and

damage. Replace stem if worn or damaged. Replace washer and inner packing if stem is replaced.

(3) Check action of spring in adjusting screw assembly. Spring must be in good condition.

(4) Inspect remaining springs for breaks, cracks, evidence of set, and fatigue. Replace unserviceable springs.

(5) Inspect body and piston for damage. Replace damaged parts.

(6) Inspect body filters. Filters should be clean and in good condition. Replace filters if necessary.

e. Reassembly.

(1) Install plugs (14, fig. 8–6) in governor body (12). Install new filters (13) if they were to be replaced.

(2) Install outer packing (8) on piston (9). Place piston on end with smaller internal bore end facing up. Install valve (10) in bore in piston. Install valve spring (11), small end first, into bore behind valve. Depress spring until larger end of spring snaps into groove in bore of piston.

(3) If packing (7) and washer (6) were removed, install packing and washer in piston.

(4) Install stem spring (5) in piston with smaller end of spring facing up. Install exhaust stem (4), with hollow end down, through stem spring and into washer and packing.

(5) Coat the interior of body (12) with grease (GAA). Install piston (9), with exhaust stem end up, into body. Push piston to bottom of bore.

(6) Install adjusting screw assembly into body above piston. Install retaining r (2) in groove in body to hold adjusting scr assembly in place.

(7) Install governor cover (1) on body.

f. Installation.

(1) Install governor (36, fig. 8–2) on co pressor with a new gasket (37). Secure gov nor with two screws (34) and lock was (35).

(2) Install nipple (50), tee (49), adap (48) and elbow (33) on governor.

(3) Connect hose (47) and tube (32) adapter and elbow.

g. Adjustment.

(1) Start engine and observe air press gage on instrument panel. Governor should load compressor when gage registers 103 107 psi.

(2) If unloading occurs below 103 psi above 107 psi, governor requires adjustment.

(3) Adjust governor as follows:

(*a*) Remove cover (1, fig. 8–6) fr governor.

(*b*) Loosen lock nut on adjusting scr assembly (3). Rotate adjusting screw clo wise to increase pressure setting or count clockwise to decrease. Tighten lock nut.

(*c*) Bleed off air by opening drain co intermittently and observe action of governo Allow pressure to build up and check unlo ing pressure. Adjust governor ((*b*) abo until pressure is in range stated.

(*d*) Install governor cover (1). Stop gine.

Section IV. AIR RESERVOIR AND LINES

8–7. Air Reservoir

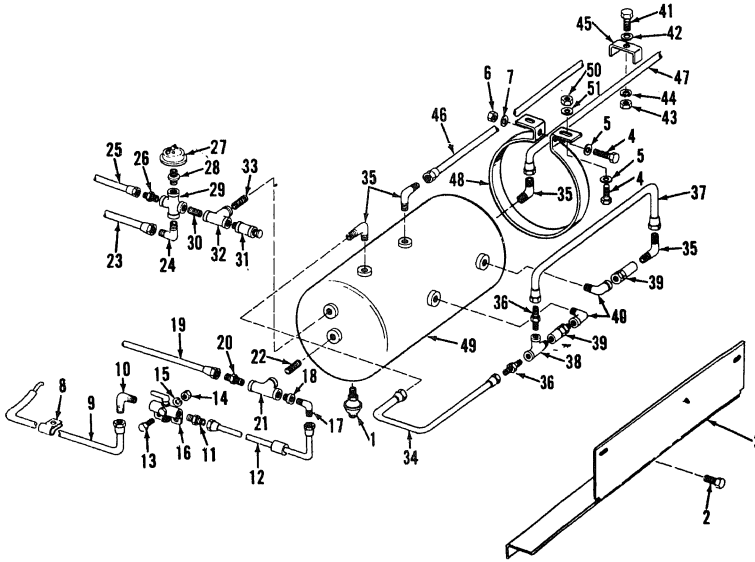
a. General. The air reservoir (fig. 8–1) is a dual compartment reservoir containing a wet and two dry reservoirs. Air from the compressor enters the wet reservoir where most of the moisture in the air can condense. The three compartments are interconnected, with check valves between each dry compartment and the wet compartment to prevent air from returning to the wet compartment. This allows the storage of enough air in the dry compartments for several brake applications even after the engine has stopped operating. A safety valve, mounted outside the wet compartment, opens if the air pressure in the tank exceeds 170 to 175 psi. An air pressure actuated switch mounted on the reservoir actuates a buzzer to warn the operator the air pressure is below 90 psi.

b. Removal. Refer to TM 5–3805–239–12 remove the air reservoir.

(1) Refer to figure 8–7 and remove tubes and fittings from the reservoir (49).

(2) Inspect condition of safety valve (1 transmitter (27), air supply valve (16), check valves (39).

c. Cleaning. Clean reservoir with clean compound, solvent (Spec. P–S–661) and b dry with compressed air.



1 Drain cock (3 rqr)
2 Screw, cap, hex-head (4 rqr)
3 Shield
4 Screw, cap, hex-head (4 rqr)
5 Washer, flat (4 rqr)
6 Nut (4 rqr)
7 Washer, lock (4 rqr)
8 Tube clamp
9 Hose, governor to supply valve
10 Elbow
11 Adapter
12 Hose, supply valve to reservoir
13 Screw, cap, hex-head (2 rqr)
14 Nut (2 rqr)
15 Washer, lock (2 rqr)
16 Air supply valve
17 Elbow
18 Reducing bushing
19 Hose, compressor to reservoir
20 Adapter
21 Tee
22 Nipple
23 Tube, reservoir to horn
24 Elbow
25 Tube, reservoir to gage
26 Adapter
27 Transmitter, air buzzer
28 Adapter
29 Pipe cross
30 Nipple
31 Safety valve
32 Tee
33 Nipple
34 Tube assembly
35 Elbow (4 rqr)
36 Adapter (2 rqr)
37 Tube assembly
38 Tee
39 Check valve (2 rqr)
40 Elbow (2 rqr)
41 Screw, cap, hex-head (2 rqr)
42 Washer, flat (2 rqr)
43 Nut (2 rqr)
44 Washer, lock (2 rqr)
45 Clamp (2 rqr)
46 Tube, reservoir to valve
47 Tube, reservoir to valve
48 Clamp bracket (2 rqr)
49 Reservoir

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Figure 8-7. Air reservoir and lines, exploded view.

d. Inspection and Repair.

(1) Inspect reservoir for evidence of leakage, dents, and damage.

(2) Check condition of threads in holes. Repair damaged threads if possible.

(3) Repair leaks and cracks by welding if

possible. Replace damaged or dented reservoirs.

e. Installation.

(1) Refer to figure 8–7 and install tubes and fittings in air reservoir.

(2) Refer to TM 5–3805–239–12 and install the air reservoir.

8–8. Safety Valve

a. General. The safety valve (fig. 8–1) protects the air system should the unloader mechanism in compressor fail to function. Air pressure will be exhausted by the safety valve to keep pressure within safe limits. Air pressure acting on a steel ball in a valve seat within the valve will force the ball off the seat if pressure reaches 170 to 180 psi. The ball will be forced from the seat against the spring pressure and air is exhausted through a hole in the spring cage. When pressure has dropped to a safe point the spring pressure will return the ball to its seat.

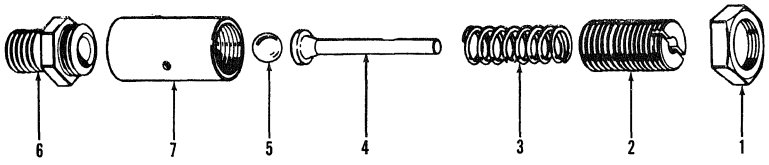
b. Removal.

(1) Open drain cocks on air reservoir (49, fig. 8–7) to relieve air pressure.

(2) Remove safety valve (31) from tee at end of air reservoir.

c. Disassembly. Clean exterior of valve in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

(1) Remove lock nut (1, fig. 8–8) and remove adjusting screw (2), spring (3), stem (4), and ball (5) from spring cage (7).



1 Lock nut
2 Adjusting screw
3 Valve spring
4 Valve stem
5 Ball
6 Body
7 Spring cage

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Figure 8–8. Air system safety valve, exploded view.

(2) Remove body (6) from spring cage.

d. Cleaning. Clean all parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

e. Inspection and Repair.

(1) Inspect stem and ball for wear and damage. Replace entire valve if ball is worn or damaged.

(2) Inspect spring for cracks, bends, and set.

(3) Inspect ball seat in body for wear and damage.

(4) Replace entire valve if any parts are worn or damaged.

f. Reassembly.

(1) Install body (6, fig. 8–8) in spring cage (7).

(2) Install ball (5), stem (4), spring (3), adjusting screw (2), and lock nut (1) in spring cage.

g. Testing.

(1) Connect an air line to body of valve.

(2) Apply 100 psi air pressure to valve. Apply soap suds to exhaust port. Leakage at port should not exceed one inch soap bubble in one second.

(3) Apply 175 psi air pressure to valve. Valve should open and exhaust air. If valve does not open at proper pressure, loosen lock nut (1, fig. 8–8) and rotate adjusting screw (2) clockwise to increase pressure at opening or counterclockwise to decrease pressure. Tighten lock nut to secure adjustment. Disconnect air line from valve.

h. Installation. Install safety valve (31, fig. 8–7) in tee at air reservoir.

8–9. Air Lines

a. General. The air lines of the system consist of tubes and hoses to deliver air to all parts of the system. An alcohol evaporator is incorporated in the system to prevent moisture from freezing in the lines and preventing air flow.

b. Inspection. If lines are suspected of leaking, inspect lines and connections. Use a soap solution at the subject spots to check for leaks when air pressure is present in the system. Check lines for kinks and breaks.

c. Removal. Remove lines by disconnecting from fittings or valves. Remove clamps as necessary to remove lines.

d. Installation. Install new lines in place of any damaged or leaking lines. Tighten connections securely. Install clamps as necessary to support lines.

Section V. WHEEL BRAKE SYSTEM

8–10. Dual Air Application Valve

a. General. The dual air application valve (fig. 8–1) is mounted below the right brake pedal. The left brake pedal is connected to the right pedal with a solid rod. When the operator depresses the left pedal the reaction is the same as if he had depressed the right pedal. The dual valve splits the brake system into two separated, fully controllable sections. Air is delivered to the two power clusters, one which operates the rear wheel brakes, the other the front wheel brakes. Failure of air in one section will not affect the operation of the other section.

b. Removal. Refer to paragraph 2–34 and remove the brake pedals and valve from the loader.

c. Disassembly.

(1) Remove four screws (4, fig. 8–9), nuts (5), and lock washers (6) and remove rod (7) from left brake pedal (10) and dual air application valve.

(2) Remove cotter pins (8) and pins (9) and remove brake pedal (10) from flange (11).

(3) Remove stop light switch (4, fig. 8–10) and bushing (5) from air valve.

Note. Clean exterior of valve with cleaning compound, solvent (Spec. P–S–661) before disassembly.

(4) Remove cotter pins (6), pivot pins (7) and pedal (9) from valve. Remove roller (8), boot (10), and plunger (11).

(5) Remove nut (12) and screw (13) from flange (41).

(6) Remove four screws (14) and lock washers (15) and separate valve bodies (37 and 38).

(7) Remove cover (16) and packings (17 and 18).

(8) Remove retaining ring (19) and exhaust shield (20). Remove seal retainers (21 and 22), guide (24), spring (25), and exhaust valve (26) from lower body (37).

(9) Remove secondary metering piston (29), packings (27 and 28), and spring (30).

(10) Remove push rod (31), valve seal (32), packing (33), guide (34), and spring (35) from bottom of upper valve body (38).

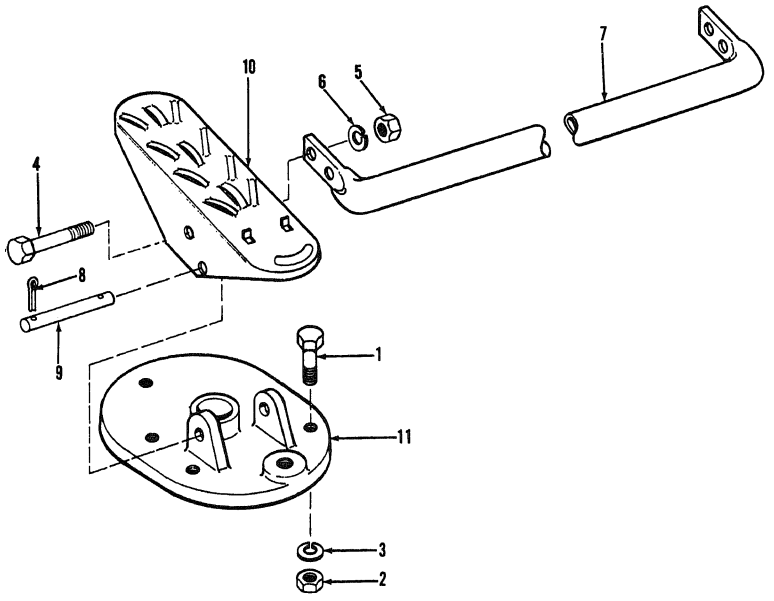
(11) Remove retaining ring (42), retainer (43), and spring (44) from piston (46). Remove piston and spring (47). Remove packing (45) from piston.

d. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

e. Inspection and Repair.

(1) Replace all packings and seals.

(2) Inspect piston and bores for wear and damage. Replace worn or damaged parts.



1 Screw, cap, hex-head (3 rqr)
2 Nut (3 rqr)
3 Washer, lock (3 rqr)
4 Screw, cap, hex-head (4 rqr)
5 Nut (4 rqr)
6 Washer, lock (4 rqr)
7 Rod
8 Pin, cotter (2 rqr)
9 Pin, pivot (2 rqr)
10 Left brake pedal
11 Mounting flange

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Figure 8-9. Left brake pedal and rod, exploded view.

(3) Inspect springs for cracks and damage. Replace unserviceable springs.

f. Reassembly.

(1) Reassemble the dual air application valve in reverse of the numerical sequence illustrated on figure 8-10 and in reverse of the sequence in *c.* above.

(2) Install pedal (10, fig. 8-9) on flange (11) and secure with pins (9) and cotter pins (8).

(3) Install rod (7) between pedal (10) and dual air application valve and secure rod to pedal and valve with four screws (4), nuts (5), and lock washers (6).

(4) Refer to paragraph 2-34 and install the dual air application valve on the loader.

8–11. Power Clusters

a. General. Two power clusters, mounted on the left side of the loader, convert air pressure into hydraulic pressure to operate the brakes. One cluster operates the front wheel brakes, the other the rear brakes. Hydraulic oil from the front power cluster (fig. 8–1) is also delivered, through the clutch cutoff valve (fig. 8–1) to the clutch cutoff on the transmission.

b. Removal. Refer to TM 5–3805–239–12 and remove the power clusters from the loader.

c. Disassembly. Clean exterior of power clusters (3 and 4, fig. 8–11) before disassembly. Drain hydraulic fluid from cylinder.

(1) Remove two screws (1, fig. 8–12) and lock washers (2) and remove air cylinder from bracket.

Note. Disassembly of the power clusters is the same. Do not mix parts of clusters. Keep parts from each assembly separate from the other.

(2) Remove eight screws (3) and lock washers (4) and remove air cylinder shell (5).

(3) Remove piston cup (6) and wiper (7) from piston and rod (8).

(4) Remove piston boot (9) and return spring (10) from cylinder head (11).

(5) Remove stroke indicator (12) and lock washer (13) from cylinder head.

(6) Remove retainer (15), screens (14), and filter (16) from head.

(7) Remove bracket (27). Remove retaining wire (19) from groove in housing (26) and remove stop plate (20), piston cups (21 and 23), piston (22), and return spring (24) from housing. Unscrew check valve (25) from housing.

(8) Remove filler plug (17) and gasket (18) from housing.

d. Cleaning. Clean all metal parts with cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

e. Inspection and Repair.

(1) Replace wiper, cups, gasket, and filter.

(2) Inspect cylinder shell for dents, cracks, and corrosion. Replace damaged shells.

(3) Inspect grooves in piston for damage. Check piston and rod for secure fit. Replace piston and rod if piston is loose.

(4) Inspect springs for cracks and damage. Replace damaged springs.

(5) Inspect bore in housing for pits, scratches, and wear. Hone cylinder if possible. Do not increase diameter or develop burs while honing. Clean reservoir ports in housing with a soft wire no larger than 0.0200 inch in diameter. Replace a worn or damaged housing.

f. Reassembly. Check all parts for cleanliness before reassembly.

(1) Lubricate all internal parts with hydraulic fluid (HBA).

(2) Install check valve (25, fig. 8–12) in housing (26). Install spring (24), cups (21 and 23), piston (22), and stop (20) in housing. Seat retaining wire (19) firmly in groove to secure parts.

(3) Install hydraulic cylinder on mounting bracket.

(4) Install piston cup (6) and wiper (7) on piston and rod (8).

(5) Install piston boot (9) in groove on piston.

(6) Saturate the piston cup and wiper and lubricate inside of shell with engine oil (OE).

(7) Install assembled piston and piston spring (10) on cylinder head (11) and compress spring to snap boot in place in groove in head.

(8) Aline cylinder shell (5) over piston and head. Slide a small diameter driver into air inlet in shell and compress piston spring (10) while sliding shell over piston and head.

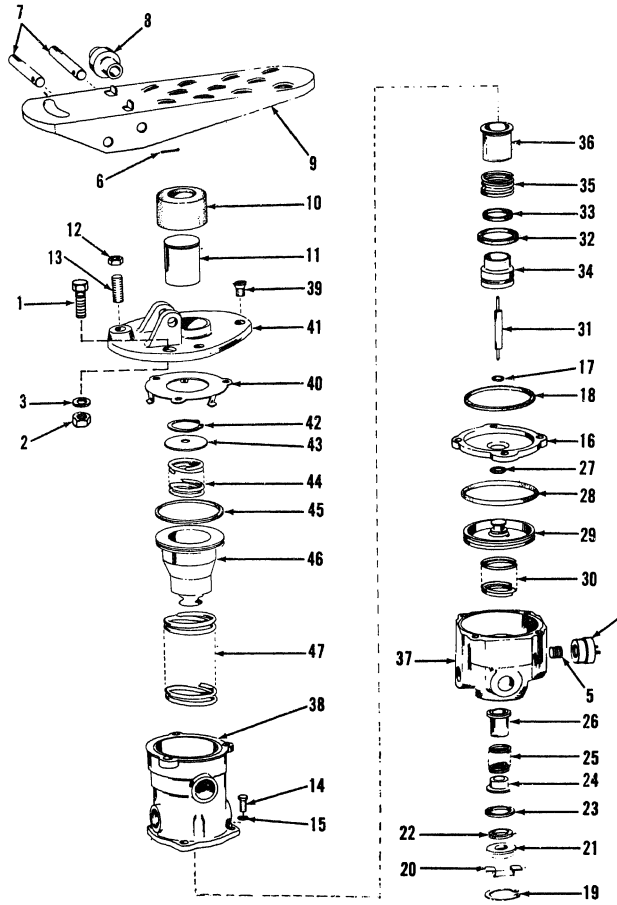
(9) Secure shell to head with eight screws (3) and lock washers (4).

(10) Install air cylinder on mounting bracket. Secure power cluster to bracket with screws (1) and lock washers (2).

g. Installation. Refer to TM 5–3805–239–12 and install the power clusters on the loader.

8–12. Wheel Brakes

a. General. The brakes on the four loader wheels are of the opposed piston expanded shoe type. Hydraulic pressure applied to the pistons in the wheel cylinders expand the push rods outward. The push rods are attached to the top of the brake shoe assemblies. As the push rods move outward from the cylinder the brake linings are forced against the inside of the brake drum, slowing and stopping the loader. When hydraulic pressure is released



•MEC 3805-239-35/8-1

Figure 8–10. Dual air application valve, exploded view.

1 Screw, cap, hex-head, 5/16–18 x 1 in. (3)
2 Nut, 5/16–18 (3)
3 Washer, lock, 5/16 in. (3)
4 Stop light switch
5 Pipe bushing
6 Pin, cotter (2)
7 Pin, pivot (2)
8 Roller
9 Pedal
10 Boot
11 Plunger
12 Nut
13 Screw
14 Screw, cap, hex-head, ¼–20 x ⅞ in. (4)
15 Washer, lock, ¼ in. (4)
16 Cover
17 Packing, preformed
18 Packing, preformed
19 Ring, retaining
20 Exhaust shield
21 Seal retainer
22 Secondary seal retainer
23 Guide seal
24 Spring guide
25 Spring
26 Exhaust valve
27 Packing, preformed
28 Packing, preformed
29 Secondary metering piston
30 Spring
31 Push rod
32 Valve seal
33 Packing, preformed
34 Valve guide
35 Spring
36 Primary inlet valve
37 Lower valve body
38 Upper valve body
39 Screw, machine (3)
40 Spring retainer
41 Mounting flange
42 Ring, retaining
43 Spring retainer
44 Spring
45 Packing, preformed
46 Primary metering piston
47 Spring

Figure 8–10—Continued.

from the cylinder, a return spring connected between the two shoes, pulls the shoes together and releases them from contact with the drums.

b. Removal.

(1) Refer to paragraph 7–4 and remove the planetary hubs and brake drums (28, fig. 7–2) from the axles.

Note. Removal is the same for both front and rear brakes.

(2) Remove brake assembly (40) (para 7–4).

Note. Brake assembly can be disassembled without removal from axle if desired.

c. Disassembly.

Note. Disassembly of the wheel brakes is similar. Where differences between front and rear wheel brakes exist they will be noted in the text and on the illustration. Keep brake assemblies separate when disassembling and reassembling.

(1) Remove shoe return spring (1, fig. 8–13).

(2) Remove two retaining washers (2), washers (4), and shim washers (front brake only) (3).

(3) Remove two retaining washers (5), retaining rings (6), and anchor pin link (7).

(4) Remove two brake shoe assemblies (8). Remove two anchor pins (13).

(5) Remove two screws (14) and lock washers (15) and remove wheel cylinder assembly (29).

(6) Remove two push rods (16) from wheel cylinder assembly.

(7) Remove bolt (17), bleeder screw (18), and seal washer (19) from wheel cylinder. Remove adapter (20) and seal washer (21).

(8) Remove cams (22) and springs (23) from adjusting screws (24) and remove adjusting screws.

(9) If guide pins (25) require replacement, drive pins from backing plate (26).

(10) If stop pin (12) requires replacement, drive pin from brake shoes.

(11) Remove brake drum felt (28) from backing plate.

d. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

e. Inspection and Repair.

(1) Inspect anchor pins for wear and damage. Replace unserviceable pins.

(2) Inspect adjusting cams and screens for wear and damage. Replace if worn or damaged.

(3) Inspect brake drums (28, fig. 7–2) for cracks, scoring, or abnormal wear. Inspect drum for out-of-round condition. Remove minor scoring or scratches. Replace cracked or out-of-round drums.

(4) Inspect backing plate for cracks,

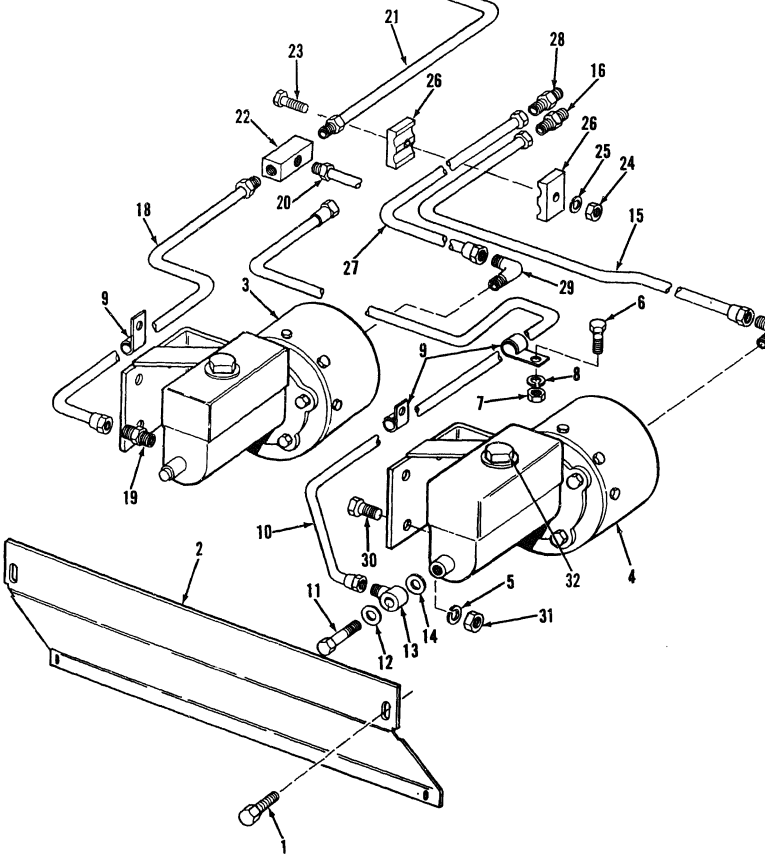


Figure 8–11. Brake power clusters and lines, exploded view.

6 Screw, cap, hex-head, ⅜–24 x 1¼ in.
7 Nut, ⅜–24
8 Washer, lock, ⅜ in.
9 Clamp (3)
10 Tube, cylinder to rear brakes
16 Tube union
17 Elbow
18 Tube, cylinder to tee
19 Adapter
20 Tube, tee to cutoff valve
21 Tube, tee to front brakes
22 Tee
27 Tube, brake valve to cluster
28 Tube union
29 Elbow
30 Screw, cap, hex-head, ⅜–16 x 1 in. (8)
31 Nut, ⅜–16 (8)
32 Filler plug (2)

Figure 8–11—Continued.

damage, and distortion. Replace damaged or distorted backing plates.

(5) Inspect brake linings on brake shoes. If linings are worn or damaged replace as follows:

(*a*) Remove rivets (9, fig. 8–13) by cutting or driving them from brake shoe. Remove lining (10).

(*b*) Clean shoe contact face.

(*c*) Inspect anchor pin sleeve bearing (27) in shoe for wear or damage. Press bearing from shoe and install new bearing if necessary.

(*d*) Clamp a new lining (10) on shoe with rivet holes in lining alined with holes in shoe.

(*e*) Drive new rivets (9) into lining and shoe with a 7/16 inch flat head drift.

(*f*) Form heads of rivets with correct tubular rivet set. Form center rivets first and follow a sequence from the center outward toward the sides and ends of shoe. Check liner with a 0.0020 inch feeler gage to assure proper contact between liner and shoes.

(6) Check shoe return spring for distortion, cracks, or evidence of stretching. Replace unserviceable springs.

(7) Inspect hydraulic wheel cylinder for signs of leakage or damaged boots. Repair cylinder (para 8–13) if necessary.

f. Reassembly.

(1) Install guide pins (25, fig. 8–13) in backing plate (26) if they were removed. Install felt (28) on backing plate.

(2) Install stop pins (12) in shoe assembly if they were removed.

(3) Install adapter (20) and seal washer (21) and bleeder screw (18), bolt (17), and seal washer (19) on wheel cylinder assembly (29).

(4) Install wheel cylinder assembly on backing plate and secure with two screws (14) and lock washers (15). Install push rods (16) in ends of cylinder.

(5) Install brake shoe assemblies (8) on backing plate and slide anchor pins (13) through plate and shoes. Secure pins with link (7) and retaining rings (6) and retaining washers (5).

(6) Install screws (24) through plate and shoe and install cams (22) and springs (23) on screws.

(7) Install washers (3) and (4) and retaining washers (2) to hold top of shoes on backing plate.

(8) Connect shoe return spring (1) to top of shoes.

g. Installation.

(1) Refer to paragraph 7–4 and install brake drum, brake assembly, and planetary hubs on axles.

(2) Connect hydraulic lines to wheel cylinders. Fill brake power clusters with fluid and refer to TM 5–3805–239–35 to bleed and check brakes.

8–13. Wheel Cylinder Assembly

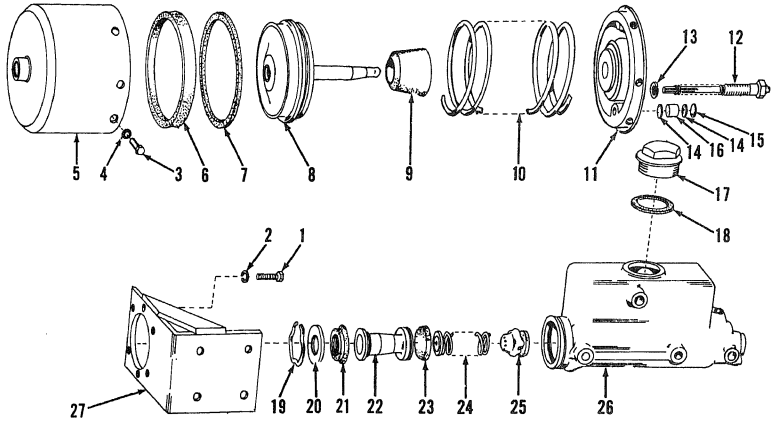
a. Removal. Refer to paragraph 8–12 and remove wheel cylinder assembly (29, fig. 8–13) from the wheel brakes.

b. Disassembly. Clean exterior of wheel cylinder assembly with a rag soaked in brake fluid (HBA).

(1) Remove boots (1, fig. 8–14) from housing (5).

(2) Remove pistons (2), cups (3), and spring (4) from housing.

c. Cleaning. Clean rubber parts and thoroughly rinse metal parts in denatured alcohol (Spec. O–A–396) or brake fluid (HBA).



1 Screw, cap, hex-head (2 rqr)
2 Washer, lock (2 rqr)
3 Screw, cap, hex-head (8 rqr)
4 Washer, lock (8 rqr)
5 Air cylinder shell
6 Piston cup
7 Cylinder wiper
8 Piston and rod
9 Piston boot
10 Piston return spring
11 Cylinder head
12 Stroke indicator
13 Washer, lock
14 Filter screen (2 rqr)
15 Filter retainer
16 Filter
17 Filler plug
18 Gasket
19 Retaining wire
20 Stop plate
21 Piston cup
22 Hydraulic piston
23 Piston cup
24 Piston return spring
25 Check valve
26 Housing
27 Mounting bracket

MEC 3805-239-35/8-12

Figure 8–12. Brake power cluster, exploded view.

d. Inspection and Repair.

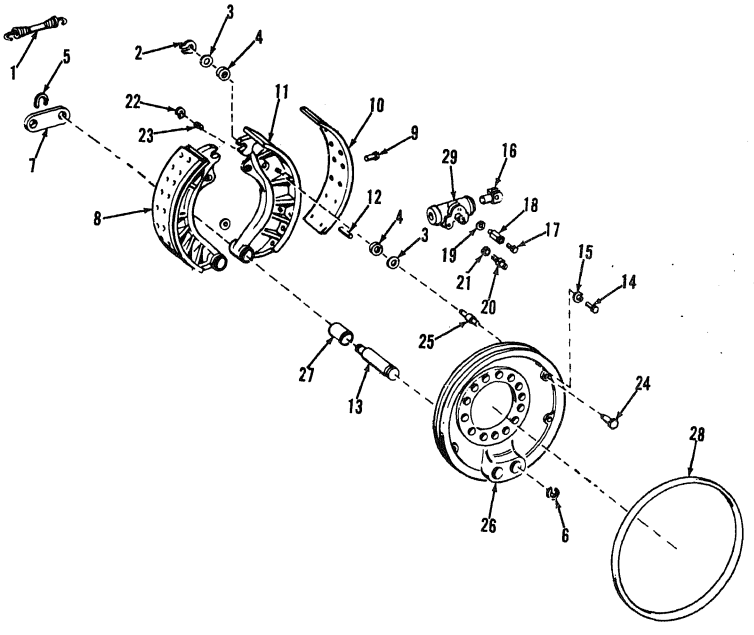
(1) Inspect bore of housing with a strong light. If pitting, scratches, and wear patterns are evident, replace housing. Remove gummy residue from bore with crocus cloth or a light hone. Do not enlarge cylinder bore in excess of 0.0070 inch.

(2) Inspect boots and cups for wear, damage, and deterioration. Replace unserviceable parts.

(3) Inspect pistons for wear and damage. Replace worn or damaged pistons.

(4) Inspect spring for cracks, wear, and distortion. Replace unserviceable springs.

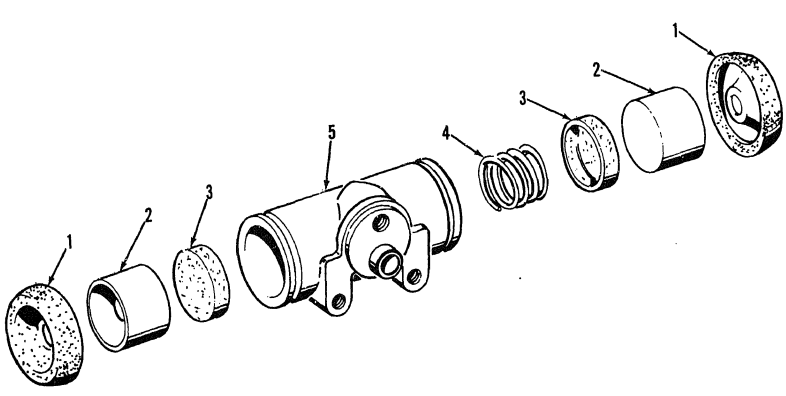
e. Reassembly. Soak parts in brake fluid (HBA) before reassembling.



1 Shoe return spring
2 Retaining washer (4 rqr)
3 Washer, shim (as rqr) (front brake only)
4 Washer (12 rqr)
5 Retaining washer (2 rqr)
6 Ring, retaining (2 rqr)
7 Anchor pin link
8 Brake shoe assembly (2 rqr)
9 Rivet (32 rqr)
10 Brake lining (2 rqr)
11 Brake shoe
12 Cam stop pin (2 rqr) (front brake only)
13 Anchor pin (2 rqr)
14 Screw, cap, hex-head, 3/8-16 x 1-1/8 in. (2 rqr)
15 Washer, lock, 3/8 in. (2 rqr)
16 Push rod (2 rqr)
17 Bolt, bleeder screw
18 Bleeder screw
19 Washer, sealing
20 Adapter
21 Washer, sealing
22 Adjusting cam (2 rqr)
23 Spring (2 rqr)
24 Adjusting screw (2 rqr)
25 Shoe guide pin (4 rqr)
26 Backing plate
27 Sleeve bearing (2 rqr) (front brake only)
28 Brake drum seal
29 Wheel cylinder assembly

MEC 3805-239-35/8-13

Figure 8-13. Wheel brake assembly, exploded view.



1 Boot (2 rqr)
2 Piston (2 rqr)
3 Piston cup (2 rqr)
4 Spring
5 Housing

MEC 3805-239-35/8-14

Figure 8–14. Wheel cylinder assembly, exploded view.

(1) Install spring (4, fig. 8–14) and cups (3) in housing (5). Do not damage lips of cup when installing.

(2) Install pistons (2) and boots (1) in housing.

f. Installation. Refer to paragraph 8–12 and install wheel cylinder assembly (29, fig. 8–13) on wheel brakes.

8–14. Clutch Cutoff Valve

a. General. The clutch cutoff valve (fig. 8–1) works in conjunction with the brake power clusters to deliver hydraulic fluid to the clutch cutoff on the transmission when the brake pedal is depressed. This halts power output from the transmission and allows the operator to work the loader or shift the transmission without the unit being in motion.

b. Removal. The clutch cutoff valve is mounted on a bracket above the hydraulic reservoir at the rear of the operator's compartment.

(1) Disconnect tubes (1 and 2, fig. 8–15) from clutch cutoff valve.

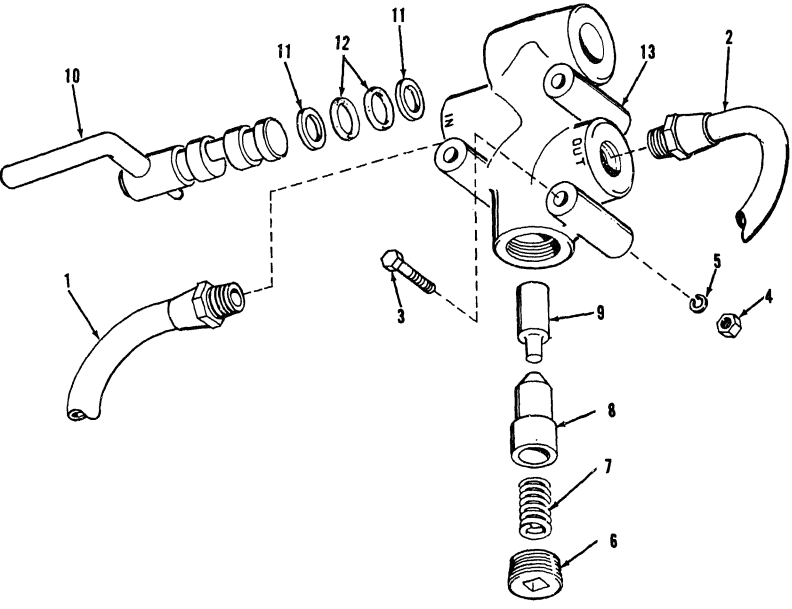
(2) Remove three screws (3), nuts (4), and lock washers (5) and remove clutch cutoff valve.

c. Disassembly.

(1) Remove pipe plug (6, fig. 8–15) and remove spring (7), plunger (8), and cam follower (9) from valve body (13).

(2) Remove cam assembly (10) from body. Remove backup rings (11) and packings (12) from cam assembly.

d. Cleaning. Clean valve parts in denatured alcohol (Spec. O–A–396) or brake fluid (HBA).



1 Tube assembly, from power cluster
2 Tube assembly, to cutoff valve
3 Screw, cap, hex-head (3 rqr)
4 Nut (3 rqr)
5 Washer, lock (3 rqr)
6 Pipe plug
7 Spring
8 Plunger
9 Follower
10 Cam assembly
11 Backup ring (2 rqr)
12 Preformed packing (2 rqr)
13 Valve housing

MEC 3805-239-35/8-15

Figure 8–15. Clutch cutoff valve, exploded view.

Inspection and Repair.

(1) Inspect spring for wear, cracks, and ortion. Replace unserviceable springs.

(2) Inspect plunger and follower for r, scores, nicks, and damage. Replace damplungers and followers.

(3) Inspect cam assembly for wear and damage. Cam assembly must fit snugly and rotate smoothly in body. Replace damaged cam assemblies.

(4) Inspect bores in body for wear and damage. Check threads for good condition. Inspect mounting areas for cracks. Replace damaged bodies.

f. Reassembly. Coat valve parts with hydraulic fluid (HBA).

(1) Install new backup rings (11, fig. 8–15) and packings (12) on cam assembly (10).

(2) Install cam assembly in valve body.

(3) Install follower (9) in valve body. Plunger must engage cam on cam assembly.

(4) Install plunger (8) and spring (7) and secure with pipe plug (6).

(5) Operate lever on cam assembly to check valve operation.

g. Installation.

(1) Install cutoff valve on bracket at top of hydraulic tank and secure three screws (2, fig. 8–15), nuts (4), and lock washers (5).

(2) Install tubes (1 and 2) in openings in valve.

(3) Refer to TM 5–3805–239–12 to check and bleed brake hydraulic system and fill hydraulic power cluster.

Section VI. PARKING BRAKE

8–15. General

a. The parking brake on the loader is a mechanical brake with internal expanding shoes. The backing plate is mounted on a boss at the front of the transmission housing. The brake drum is bolted to the front output flange yoke.

b. A lever, mounted in the operator's compartment is connected to a linkage. The linkage terminates at the parking brake. When the lever is raised the brake shoes are expanded and press against the brake drum, holding the loader in position.

8–16. Parking Brake

a. Removal. Refer to TM 5–3805–239–12 and remove the parking brake from the loader.

b. Disassembly.

(1) Remove four screws (1, fig. 8–16) and remove brake drum (2) from flange yoke.

(2) Remove two return springs (3) and roller (4). Remove operating cam lever (5) from brake shoes.

(3) Remove four screws (9) and remove backing plate (10) from transmission.

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

d. Inspection and Repair.

(1) Inspect brake drum for scoring, cracks, and wear. Replace worn or damaged brake drum.

(2) Inspect roller for wear or out-of-round condition. Replace worn rollers.

(3) Inspect springs for cracks, distortion, and stretching. Replace unserviceable springs.

(4) Inspect brake shoes and linings for wear, deterioration, and damage. Replace linings if worn, deteriorated, or damaged.

(*a*) Remove rivets (7 fig. 8–16) by cutting or driving them from brake shoe. Remove linings (6).

(*b*) Clean shoe contact face.

(*c*) Inspect shoes (8) for cracks and damage.

(*d*) Clamp a new lining (7) on shoe (8) with holes in lining alined with holes in shoe.

(*e*) Drive new rivets (7) in lining and shoe with a suitable flat head drift.

(*f*) Form heads of rivets with a suitable rivet set. Form center rivets first and follow a sequence from center outwards towards sides and ends of shoe.

(5) Inspect operating cam lever for wear and damage and proper operation.

(6) Inspect backing plate for damage, dents, and secure mounting of parts. Replace plate if damaged.

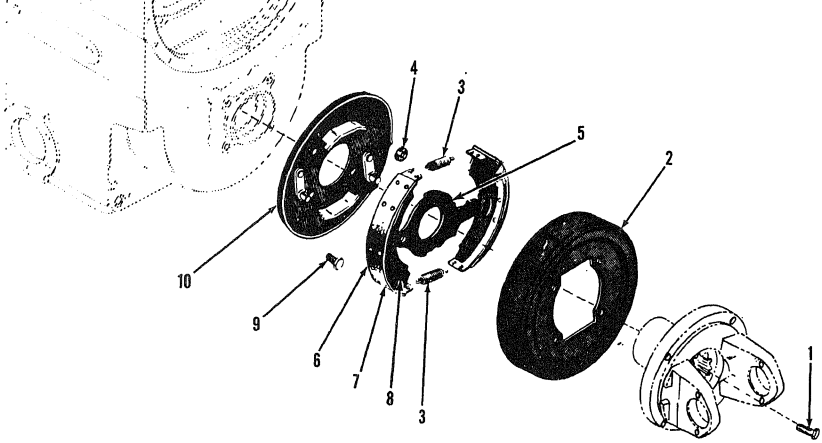
e. Reassembly.

(1) Install backing plate (10, fig. 8–16) on transmission and secure with four screws (9).

(2) Install roller (4), operating cam lever (5), brake shoe assemblies, and shoe return springs (3) on backing plate.

(3) Install brake drum (2) on flange yoke and secure with four screws (1).

f. Installation. Refer to TM 5–3805–239–12 and install the parking brake on the loader.



1 Screw, cap, hex-head (4 rqr)
2 Brake drum
3 Return spring (2 rqr)
4 Roller
5 Operating cam lever
6 Brake lining (2 rqr)
7 Rivet (24 rqr)
8 Brake shoe (2 rqr)
9 Screw, cap, hex-head (4 rqr)
10 Backing plate

MEC 3805-239-35/8-16

Figure 8-16. Parking brake, exploded view.

CHAPTER 9

ENGINE ACCESSORIES REPAIR INSTRUCTIONS

Section I. STARTER

9–1. General

a. The loader engine is equipped with an electrical starter, a generator, and a voltage regulator. Other engine accessories such as the water pump, fuel injection pump, filters, and turbocharger are covered in their appropriate sections of the engine repair instructions.

b. The starter is a solenoid operated, 24-volt, overrunning-sprag clutch type with a fully enclosed shift lever and plunger. When the neutral start switch is depressed the solenoid is energized and the plunger shifts the starter drive into engagement with the flywheel ring gear and closes contacts to complete the circuit to the starter motor.

c. Once the clutch is engaged, the clutch will not disengage during intermittent engine firing, preventing damage to the starter gear and ring gear. When the engine starts the clutch of the starter drive allows the starter gear to rotate faster than the starter armature, preventing damage to the starter from overrunning.

d. When the switch is released, a return spring moves the plunger to open the contacts and move the shift lever, disengaging the gears.

e. The starter armature is supported at three points by bronze bearings which are lubricated by oil wicks.

9–2. Starter

a. Removal. Refer to TM 5–3805–237–12 and remove the starter from the engine.

b. Testing. When a starter is tested, check for unusual noises or vibration that might indicate an unserviceable condition. If either condition exists, do not attempt any further testing until starter has been repaired.

(1) *No load test.*

(*a*) Connect the starter in a test stand as illustrated on figure 9–1.

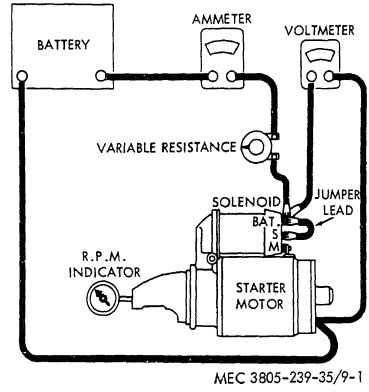


Figure 9–1. No-load test hook up.

(*b*) Energize the solenoid by connecting the jumper lead from the solenoid battery terminal to the solenoid switch terminal. Check rotation speed. Adjust the variable resistance to obtain 22.0 volts. The minimum speed should be 7000 rpm (revolutions per minute). Check the current draw on the ammeter. Maximum current draw should be 90 amperes and minimum should be 60 amperes.

Caution: **When testing starter never operate the starter more than 30 seconds at a time. Allow the starter to cool off at least 2 minutes between cycles. Overheating, caused**

by excessive cranking, can seriously damage the starter.

(*c*) If the above conditions are not met, disassemble and repair the starter.

(2) *Lock torque test.*

(*a*) Connect the starter in a test stand as illustrated in figure 9–2. The starter should be securely mounted and a brake arm hooked to the starter gear.

Caution: **During test, make certain end of brake arm does not slip off gear when current is applied.**

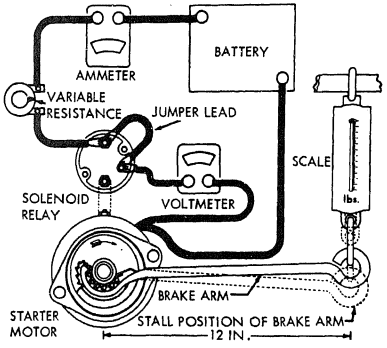


Figure 9–2. Lock torque test hook up.

(*b*) Lock torque test is a minimum of 26 foot-pounds at 500 amperes at approximately 3.5 volts.

(*c*) If the above conditions are not met, disassemble and repair the starter.

(3) *Waterproof test.*

(*a*) Connect an air line to the frame of the starter. Remove a plug and a wick, install a fitting, and connect to an air hose.

(*b*) Submerge the starter in clean water up to the gear housing and clutch assembly area. Do not allow water to enter the gear housing or clutch area.

(*c*) Apply air pressure slowly. Watch for air bubbles. Increase the air pressure to 6 psi.

(*d*) With the air pressure remaining at 6 psi, allow the starter to remain submerged for one minute. No leaks should be indicated during this period.

(*e*) If leaks are indicated, disassemble and repair starter.

c. Disassembly.

(1) Remove and disassemble commutator end plate and brush holder in the numerical sequence as illustrated on figure 9–3.

(2) Disassemble the drive housing, lever housing, clutch, and starter frame in the numerical sequence as illustrated on figure 9–4. Scribe a mark on the drive housing and lever housing to locate position for reassembly.

(3) Disassemble the solenoid assembly (14, fig. 9–3) in the numerical sequence as illustrated on figure 9–5.

d. Cleaning.

(1) Clean all parts, with the exception of the field windings, armature, brushes, solenoid, and insulators, in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

Warning: **The solvent is highly inflammable. Do not use solvent near an open flame.**

(2) Clean field windings with a cloth dampened in the solvent. Do not damage protective insulation coating. Dry thoroughly with compressed air.

(3) Remove all loose particles from armature. Clean commutator lightly with No. 00 sandpaper and remove dust with compressed air. Use a sharp instrument to clean all dirt and dust from between commutator bars.

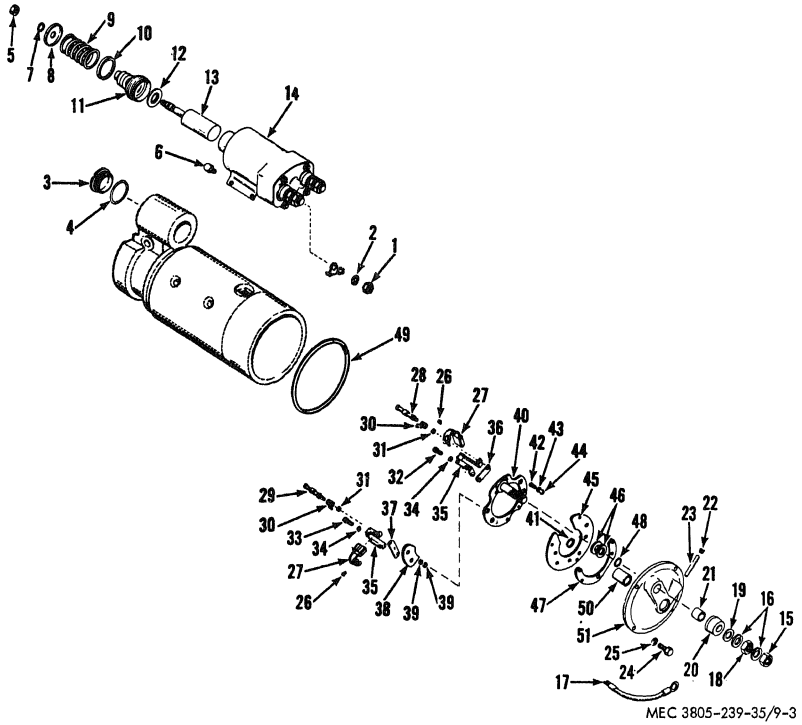
(4) Clean brush holder and solenoid with a cloth dampened in solvent and dry thoroughly. Clean brushes with a dry cloth only.

e. Inspection and Repair.

(1) Inspect armature shaft bearing surfaces for wear and scoring. Inspect splines on armature for wear and damage. Check condition of soldered wires. Replace armature if worn, damaged or scored. Resolder wires if necessary.

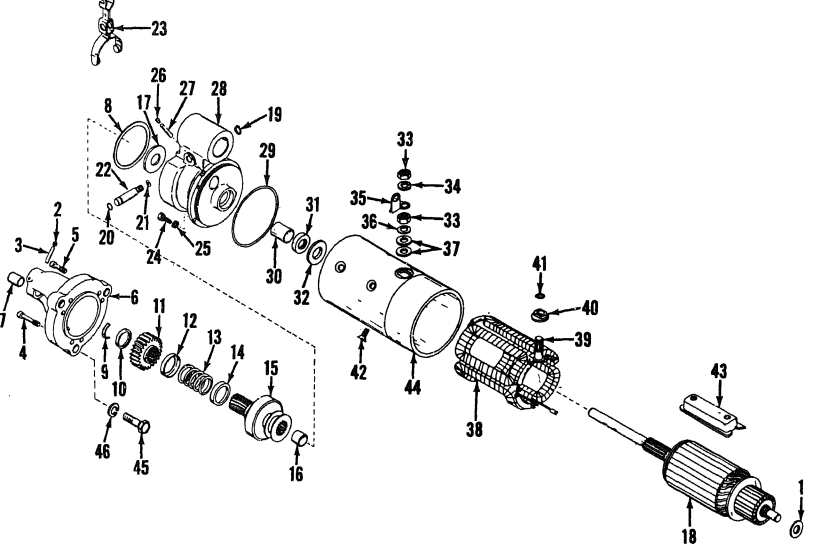
(2) Inspect condition of commutator for high mica, scoring, or out-of-round condition. Check run out with a dial indicator. If commutator is out-of-round 0.020 inch or worn, turn down commutator.

(3) Check armature for shorts on a growler. Clean slots of commutator if necessary. Check for grounds with a test lamp. Replace



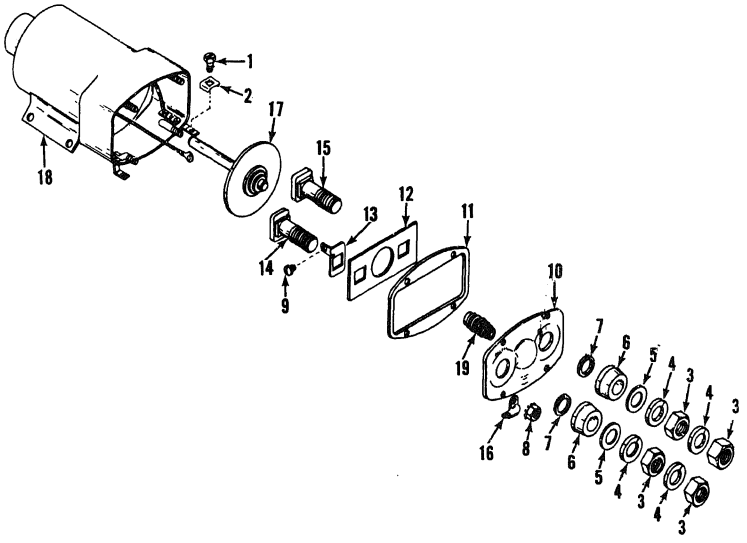
1 Nut, ½–13 (2)
2 Washer, ½ in. (2)
3 Plug
4 Gasket
5 Nut, lock
6 Screw, w/washer (4)
7 Retaining ring
8 Spring retainer
9 Plunger spring
10 Spring retainer
11 Boot
12 Flat washer
13 Solenoid plunger
14 Solenoid
15 Nut, ⅜–16
16 Washer, lock, ⅜ in. (2)
17 Solenoid lead
18 Nut, jam, ⅜–16
19 Washer, flat, ⅜ in.
20 Insulator
21 Insulating bushing
22 Plug
23 Wick
24 Screw, cap, hex-head (4)
25 Washer, lock (4)
26 Screw, machine (8)
27 Brush (8)
28 Brush holder screw (2)
29 Brush holder screw (2)
30 Brush spring (8)
31 Washer, lock (4)
32 Screw, machine (4)
33 Screw, machine (4)
34 Washer, lock (8)
35 Brush holder (4)
36 Plate (2)
37 Plate (2)
38 Insulator (2)
39 Washer (8)
40 Brush holder plate, w/stud
41 Preformed packing
42 Screw, machine, No. 8 x ½ in. (3)
43 Washer, lock, No. 8 (3)
44 Washer, flat, No. 8 (3)
45 Insulator
46 Insulating washer (2)
47 Support plate
48 Preformed packing
49 Preformed packing
50 Bearing
51 Commutator end plate

Figure 9–3. Solenoid, commutator end plate, and brush holder, exploded view.



1 Spacing washer
2 Plug
3 Wick
4 Screw, cap, socket head, 5/16–18 x 1½ in. (5)
5 Screw, cap, socket head, 5/16–18 x 55/64 in. (1)
6 Pinion housing
7 Bearing
8 Housing gasket
9 Washer, split (2)
10 Gear retainer
11 Starter pinion gear
12 Spring retainer
13 Clutch spring
14 Spring retainer
15 Starter drive
16 Bearing
17 Thrust washer
18 Armature
19 Retaining ring
20 Preformed packing
21 Preformed packing
22 Lever shaft
23 Shift lever
24 Screw, cap, hex-head, ¼ x 28 x 1 in. (5)
25 Washer, lock, ¼ in. (5)
26 Plug
27 Wick
28 Lever housing
29 Preformed packing
30 Bearing
31 Oil seal
32 Thrust washer
33 Nut, ½–13 (2)
34 Washer, lock, ½ in.
35 Connector
36 Washer, flat, ½ in.
37 Insulating washer (2)
38 Field windings
39 Terminal stud
40 Insulator
41 Gasket
42 Pole shoe screw (8)
43 Pole shoe (4)
44 Frame
45 Screw, cap, hex-head, ⅝–11 x 2 in. (3)
46 Washer, lock, ⅝ in. (3)

Figure 9–4. Pinion housing, lever housing, and frame, exploded view.



1 Screw, machine (2)
2 Terminal clip (2)
3 Nut, ½–13 (4)
4 Washer, lock, ½ in. (4)
5 Washer, flat, ½ in. (2)
6 Insulating bushing (2)
7 Insulating washer (2)
8 Nut, w/washer, No. 10 (4)
9 Screw, machine
10 Plate
11 Plate gasket
12 Insulator
13 Terminal
14 Terminal stud
15 Terminal stud
16 Ground connector
17 Contact disk assembly
18 Case and coil assembly
19 Spring

Figure 9–5. Solenoid, exploded view.

armature if shorts and grounds cannot be corrected. Refer to TM 5–764 for procedures for testing the armature.

(4) Inspect brushes for cracks, wear, damage and loose or broken wires. If brushes are worn to less than ⅜ inch, replace brushes.

(5) Check brush spring tension. Minimum spring tension should be 80 ounces. Replace weak springs as a set.

(6) Check all bearings, housing, springs, and shafts against tolerances listed in table 1–1. Replace all parts not conforming to repair and rebuild standards.

(7) Replace all worn or defective parts.

f. Reassembly.

Note. Lubricate all working surfaces of shaft and bearings and the wicks with engine oil (OE 10) before installing.

(1) Reassemble the solenoid in reverse of the numerical sequence as illustrated on figure 9–5.

(2) Reassemble the housings, armature, and frame in reverse of the numerical sequence as illustrated on figure 9–4.

(3) After installing field windings in frame, check windings with a multimeter as follows:

(*a*) Touch one probe to the terminal stud (39, fig. 9–4) and other probe to each field winding connection. Multimeter should show a reading or closed circuit for each check. If circuit is open, replace field windings.

(*b*) Touch one probe to terminal stud and other probe to unpainted surface on frame. If meter shows a reading windings are grounded and should be replaced.

(*c*) After installing drive clutch and lever, check clutch for free movement on armature shaft and locking action when reversed. If clutch does not lock immediately replace clutch.

(*d*) Reassemble brush holder and commutator end in the reverse of the numerical sequence as illustrated on figure 9–3.

(*e*) After installing solenoid and plunger parts, check clearance of pinion gear by pushing clutch towards commutator end as shown in figure 9–6. Clearance should be 23/64 inch.

(*f*) After completing reassembly of starter, test starter as described in (*b*) above.

g. Installation. Refer to TM 5–3805–237 12 and install starter.

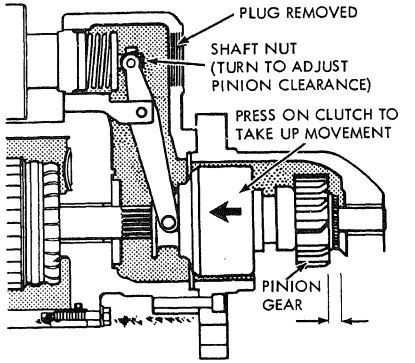


Figure 9–6. Checking pinion gear clearance.

Section II. GENERATOR

9–3. General

a. The generating system of the loader consists of an alternating current generator (fig. 1–1), a voltage regulator (fig. 1–1), a polarity protector (fig. 1–1), and the batteries (fig. 1–1). The system is basically the same as a direct current system.

b. In the alternating current generator the magnetic field is rotated and the conductor is stationary. Cutting of the flux lines by the magnetic field induces a voltage in the conductor and out through the system.

c. The current as produced by the generator is alternating current. Six diodes mounted in the generator rectify the current to direct current for use in the 24-volt system (fig. 1–1).

d. The generator brush holder assembly is internally wired with a capacitor as an integral part. This capacitor supplies the radio interference suppression.

9–4. Generator

a. Generator Tests. The following tests should be performed to a suspected faulty generator before removing the generator. The tests will help to isolate the trouble and aid in determining repair required.

(1) *Test precautions.*

(*a*) Do not disconnect generator output lead while generator is operating.

(*b*) Do not disconnect voltage regulator while generator is operating.

(*c*) Do not ground generator field terminal. Observe polarity of the voltmeter and ammeter when placing them in the circuit.

(*d*) Check battery condition. Batteries should be fully charged before testing generator.

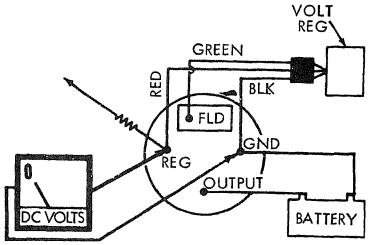
(2) *Isolation diode test.*

(*a*) Connect a direct current voltmeter in the circuit as shown on figure 9–7.

(*b*) With the master switch in the off position, observe voltmeter.

(*c*) Voltmeter should read 0 volts across regulator terminal and ground terminal.

(*d*) Switch voltmeter probe from auxil-



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Figure 9–7. Isolation diode test hook up.

iary terminal to the output terminal. If voltage is still 0 volts, isolation diode is defective.

(3) *Field circuit test.*

(*a*) Connect voltmeter as shown in figure 9–7.

(*b*) Place master switch in on position. Do not start engine. Voltmeter should read 3.0 to 4.0 volts. If voltage is higher than this field circuit and brushes are defective.

(*c*) If voltmeter reads 0 volts check field excitation resistor (24, fig. 1–1). Refer to TM 5–3805–239–12 to replace resistor.

(*d*) If voltage does not read 3.0 to 4.0 volts as above check field current draw ((5) below).

(4) *Output test.*

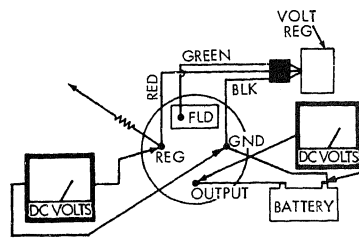
(*a*) Start the loader engine. Connect a direct current voltmeter across the regulator and ground terminals as illustrated in figure 9–8.

(*b*) Voltmeter should read 29.2 to 29.6 volts.

(*c*) Connect voltmeter between battery and output terminal as illustrated in figure 9–8. Voltmeter should read 28.2 to 28.6 volts. If difference is more than one volt, isolation diode is defective.

(5) *Field draw test.*

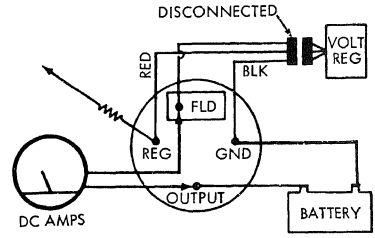
(*a*) Disconnect leads to voltage regulator.



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Figure 9–8. Generator output test hook up.

(*b*) With the master switch in the off position, connect a direct current ammeter between the field terminal and the output terminal as illustrated in figure 9–9.



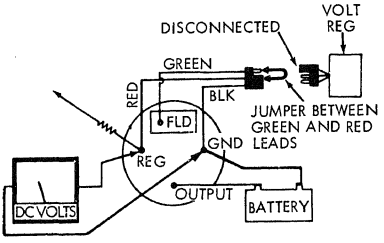
MEC 3805-239-35/9-9

Figure 9–9. Field draw test hook up.

(*c*) Current reading on ammeter should be 1.5 to 2.0 amperes.

(6) *Generator and voltage regulator test.* This test isolates the defect to either the generator or the voltage regulator.

(*a*) Disconnect leads to voltage regulator and connect a jumper between the red and green leads from the generator as illustrated in figure 9–10.



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Figure 9–10. Generator test hook up.

(*b*) Connect a direct current voltmeter between regulator and ground terminals. Place the master switch in the on position and start the engine and run at idle speed.

(*c*) If voltmeter now reads 29.2 to 29.6 volts but did not when performing output test ((4) above), the regulator is defective and should be replaced.

(*d*) If voltage does not rise at the regulator terminal, the leads between the generator and regulator are defective or the generator stator or diodes are defective. If the field circuit checked out properly ((5) above), replace leads and check stator and diodes.

b. Removal. Refer to TM 5–3805–239–12 and remove the generator from the loader.

c. Disassembly.

(1) Remove nut (1, fig. 9–11), washer (2) and insulator (3) from field terminal.

(2) Remove rear cover (5) and gasket (6).

(3) Remove screw (13) and washer (11) from wire (12).

(4) Remove nut (7) and washer (8) and two nuts (9) and washers (10) and remove isolation diode (33).

(5) Remove two screws (14) and remove brush assembly (16) and insulator (15).

(6) Remove four screws (17). Pry rotor (25) and front housing (21) as an assembly from stator (25) and rear housing.

(7) Tap shaft of rotor (25) on a block of wood and push rotor from front housing (21).

(8) Remove screws (18) and remove retainer (19). Remove bearing (20) from housing (21).

(9) Remove rubber sealant retaining leads from rotor to the slip ring assembly (23). Unsolder leads and remove from slip ring assembly.

(10) Remove screw (22) from rotor shaft. Insert a ¼–28 x 1¼ screw into end of shaft and screw into shaft to pull slip ring assembly (23) from shaft.

(11) Remove bearing (24) from shaft using a suitable puller.

(12) Remove four nuts (26), insulating washers (27) and nuts (28). Remove rear housing (36) from diodes and stator (35).

(13) Test rectifying diodes (31 and 32) with a reliable diode tester. If diodes are shorted, replace diodes as an assembly. Do not replace individual diodes.

(14) Check stator (35) for grounding with an ohmmeter. Place one probe on the stator lead, the other on stator laminations. The meter should show no continuity. If stator is grounded, replace stator.

(15) Unsolder leads from diodes as follows:

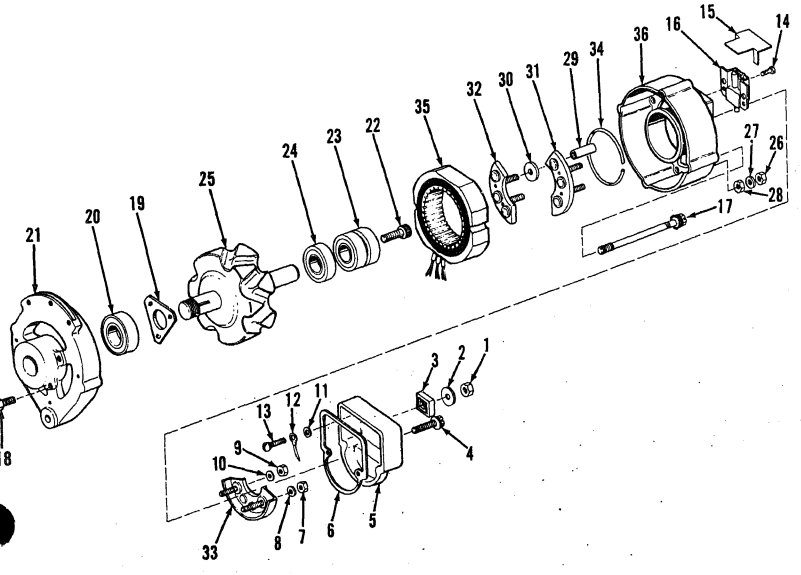
(*a*) Tag diode and stator leads for correct installation.

(*b*) Grasp diode lead with a pliers between the diode and stator lead to apply better heat dissipation.

(*c*) Unsolder leads from diode. Solder new diode to stator leads.

Note. Positive diode (31) will have red printing on body. Negative diode (32) will have black printing.

(*d*) Use only rosin core solder to solder leads. Coat solder joints with lacquer.



1 Nut, 10-24
2 Washer, insulating
3 Insulator
4 Screw, 8 x 3/4 in. (2 rqr)
5 Rear cover
6 Gasket
7 Nut, 1/4-20
8 Insulator
9 Nut, 10-24 (2 rqr)
10 Insulator (2 rqr)
11 Washer, flat, No. 10
12 Field wire
13 Screw, 10-24
14 Screw (2 rqr)
15 Insulator
16 Brush assembly
17 Screw 10-32 x 3-1/8 in. (4 rqr)
18 Screw (3 rqr)
19 Bearing retainer
20 Front bearing
21 Front housing
22 Screw
23 Slip ring assembly
24 Bearing
25 Rotor assembly
26 Nut, 10-24 (4 rqr)
27 Washer, insulating (4 rqr)
28 Nut (4 rqr)
29 Insulator (4 rqr)
30 Washer, insulating (4 rqr)
31 Positive diode
32 Negative diode
33 Isolation diode
34 Bearing retainer
35 Stator assembly
36 Rear housing

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Figure 9–11. Generator, exploded view.

d. Cleaning. Clean all parts, with the exception of stator, rotor and brushes, in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

(1) Clean stator with a cloth dampened in the solvent. Do not damage protective insulation. Dry thoroughly with compressed air.

(2) Remove all loose particles from rotor. Clean slip rings thoroughly to remove all dust and particles.

(3) Clean brush assembly with a cloth dampened in solvent and dry thoroughly.

e. Inspection and Repair.

(1) Inspect brush assembly for wear. If worn to more than half the length, replace brush assembly.

(2) Inspect slip rings for wear and damage. Replace worn or damaged slip rings.

(3) Inspect bearings for wear and damage. Rotate bearings to check operation. Replace defective bearings.

(4) Inspect rotor and windings for wear and damage. Inspect bearing surfaces for wear. Replace worn or defective rotor.

(*a*) Check continuity of rotor windings.

(*b*) Check current draw of windings. Windings should draw 1.2 to 2.5 amperes at 20 volts.

(*c*) Check resistance of windings. Resistance should be 11 to 14 ohms.

(5) Check stator for shorts and leakage and for continuity. If evidence of shorts or leakage occurs or if continuity checks reveal stator is defective, replace stator.

(6) Inspect housings for cracks and damage. Replace defective housings.

f. Reassembly.

(1) Install diodes (31 and 32, fig. 9–11) and stator (35) on rear housing (36) with washers (30) and insulators (29). Secure diodes with nuts (28).

(2) Clean bearing (20) and bore in housing and press bearing into housing. Apply pressure to outer race of bearing only.

(3) Install bearing retainer (19) and secure with screws (18).

(4) Install bearings (24) and slip ring assembly (23) on shaft of rotor (25) using a suitable pressing tool. Install screw (22) in shaft.

(5) Place slip ring end of rotor (25) in a steel tube 2 inches in diameter at least 2½ inches long, with a quarter inch notch in one side to protect rotor slip ring leads.

(6) Press front housing (21) and bearing (20) over shaft of rotor. Do not press on outer race of front bearing.

(7) Install rear housing (36) on front housing (21). Aline slots in rotor (25) with openings in housings. Install screws (17) through housings. Tighten screws evenly to draw housings together.

(8) Install brush assembly (16) an insulator (15) and secure with screws (14).

(9) Install screw (13) through field lead (12), washer (11) and cover (5).

(10) Install cover (5) and gasket (6) rear housing and secure with screws (4).

(11) Install insulator (3), washer (2) and nut (1) on screw (13) outside of rear cover.

(12) Install nuts (26) and washers (27) on diode studs.

(13) Install isolation diode (33) on rear cover and secure with nuts (7 and 9) and washers (8 and 10).

g. Installation. Refer to TM 5–3805–239–12 and install the generator on the loader. Test the generator as outlined in *a* above to check operation.

Section III. VOLTAGE REGULATOR

9–5. General

a. Protection of the engine circuits and the batteries is supplied by the voltage regulator. The regulator is mounted on a bracket with the hourmeter on the left side of the radiator support.

b. The voltage regulator is a sealed unit with little maintenance requirements. A slight adjustment in the voltage regulation is possible through an adjustment screw and a link at the rear of the regulator.

9–6. Voltage Regulator

a. Removal. Refer to TM 5–3805–239–12 and remove the voltage regulator if any of the tests (para 9–4) show the regulator to be defective.

b. Adjustment. Refer to TM 5–3805–239–12

the adjustments to the voltage re-

c. Installation. Refer to TM 5–3805–239–12 and install the voltage regulator.

Section IV. MISCELLANEOUS ELECTRICAL COMPONENTS

9–7. General

a. Additional components of the engine and loader electrical system are shown on the electric system diagram (fig. 1–1).

b. These consist of various switches, gages, and protective devices, such as circuit breakers and the polarity protector.

9–8. Electrical Components

a. Electrical Circuit Checks. If electrical circuit checks or troubleshooting indicate that a switch, gage, or protective device is not operating properly, the component must be replaced.

b. Removal.

(1) *Instruments and gages.* Refer to TM 5–3805–239–12 to remove instruments, gages, and switches from the instrument panel.

(2) *Circuit breakers.* Refer to TM 5–3805–239–12 to remove circuit breakers from the loader.

(3) *Transmitters.* Transmitters (or sending switches) are used to actuate the warning lights and buzzers for the air system and transmission converter temperature, to actuate the coolant temperature gage, and the vehicle stop lights. Refer to TM 5–3805–239–12 to remove the transmitters.

(4) *Polarity protector and field excitation resistor.* Refer to TM 5–3805–239–12 to remove the polarity protector and generator field excitation resistor.

(5) *Hourmeter.* An hourmeter is used to establish elapsed running time of the engine. Refer to TM 5–3805–239–12 and remove the hourmeter.

c. Installation. Refer to TM 5–3805–239–12 to install the electrical components removed in *b* above.

CHAPTER 10
FRAME COMPONENT REPAIR INSTRUCTIONS

Section I. GENERAL

10–1. Description

a. The loader is essentially a two-section vehicle, connected at the center with pivot pins which rotate in bearings. This method of construction allows the loader to pivot to various angles to aid in fast loading operations and smaller necessary working areas. The pivoting feature also provides the steering action of the loader, with the entire front section turning to guide the loader.

b. Drive shafts extending from the transmission provide motive power to the drive axles. The rear shaft is directly connected to the axle. The front shaft is in two sections, one shaft connecting the transmission to a universal joint and bearing support assembly mounted on the rear section and a second drive shaft extending from the support drives the front axle.

c. The front section supports the front axle and mounts the boom and bucket and connects the lift and dump cylinders to the operating portions. The rear section provides a base for the engine, platform, and operator's compartment, and supports the rear axle.

10–2. Construction

a. Basically, the frame sections are of welded steel plates. The counterweight at the rear of the frame is an integral part of the rear section. Guards for the front lights are mounted on the upper portion of the front section.

b. The radiator support and engine are mounted on the rear frame, with the transmission supported on the frame at the front of the engine. Pivot points of the front section mate with corresponding points on the rear section with pins extending through the flanges and rotating in the bearings.

Section II. DRIVE SHAFTS

10–3. Rear Drive Shaft

a. Removal. Refer to TM 5–3805–239–12 and remove the rear drive shaft (3, fig. 10–1) from the loader.

b. Disassembly.

(1) Remove screws (1, fig. 10–2), lock plates (2), and cover plate (3) and remove two cross and bearing assemblies (4) from drive shaft. Remove lubrication fittings (10).

Note. Cross and bearing assemblies may have been removed during removal of drive shaft from loader.

(2) Remove dust cap (5), washer (6), and felt washer (7) and separate yoke flange (8) and slip yoke (9).

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

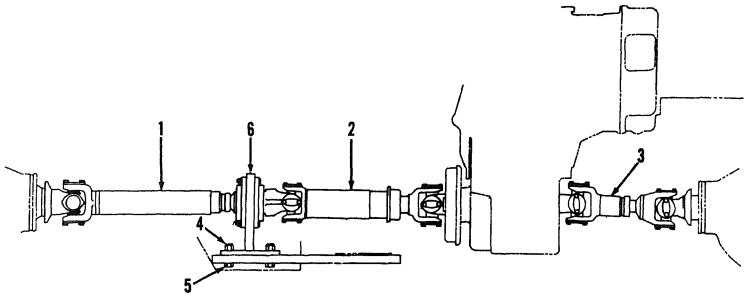
d. Inspection and Repair.

(1) Inspect cross and bearing assemblies for wear and damage. Replace defective parts.

(2) Inspect dust cap and washers for damage and deterioration. Replace defective parts.

(3) Inspect yoke flange for damage or cracks at yoke end and damage to splines. Replace damaged flange.

(4) Inspect slip yoke for damage to connecting flange, to threads, and to internal splines. Replace flange if damaged.



1 Front drive shaft
2 Center drive shaft
3 Rear drive shaft
4 Screw, cap, hex-head, 3/4-16 x 3 in. (4 rqr)
5 Nut, 3/4-16 (4 rqr)
6 Bearing and support assembly

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Figure 10–1. Drive shaft and support, installed view.

e. Reassembly.

(1) Coat splines of yoke flange (8, fig. 10–2) with grease (GAA) and install flange through dust cap (5) and washers (6 and 7) and into bore of slip yoke (9). Splines of parts must meet and yoke flange must slide smoothly in and out of slip yoke. Tighten dust cap (5) to cover mating area.

(2) Install lubrication fittings (10) in cross and bearing assemblies (4) and install cross and bearings in flanges of slip yoke (9) and yoke flange (8).

(3) Install two cover plates (3) and lock plates (2) and secure with four screws (1) on each yoke.

Note. Remaining two plates will be installed when drive shaft is installed on loader.

f. Installation. Refer to TM 5–3805–239–12 and install rear drive shaft on loader.

10–4. Center Drive Shaft

a. Removal. Refer to TM 5–3805–239–12 and remove center drive shaft (2, fig. 10–1) from the loader.

b. Disassembly.

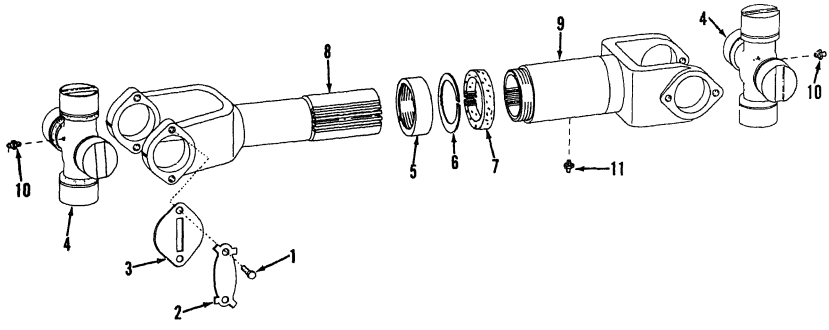
(1) Remove screws (1, fig. 10–3) and remove lock plates (2) and cover plates (3). Remove cross and bearing assemblies (5) from yokes. Remove lubrication fittings (4).

Note. Cross and bearing assemblies may have been removed during removal of drive shaft from loader.

(2) Remove retaining ring (6) from groove in sleeve yoke (14). Remove washers (7, 8, and 9) and slide splined yoke (12) from sleeve yoke. Use care not to drop balls (11) and springs (10) when removing yoke.

(3) Remove lubrication fitting (13).

c. Cleaning. Clean all metal parts in cleaning



1 Screw, cap, hex-head, 5/16-24 x 1/2 in. (16 rqr)
2 Lock plate (8 rqr)
3 Cover plate (8 rqr)
4 Cross and bearing assembly (2 rqr)
5 Dust cap
6 Washer
7 Washer, felt
8 Yoke flange
9 Slip yoke
10 Lubrication fitting (2 rqr)
11 Lubrication fitting

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Figure 10–2. Rear drive shaft, exploded view.

compound, solvent (P–S–661) and dry thoroughly with compressed air.

d. Inspection and Repair.

(1) Inspect cross and bearing assemblies for wear and damage. Replace defective parts.

(2) Inspect thrust washers for wear and damage. Inspect felt washer for serviceable condition. Replace defective parts.

(3) Inspect springs for cracks and breaks and weakened condition. Replace springs if unserviceable.

(4) Inspect balls for wear and flat spots. Replace worn or damaged balls.

(5) Inspect sleeve yoke for damage to slots and for cracks in yoke. Replace damaged yokes.

(6) Inspect splined yoke for damage to ball slots and cracks in yoke. Replace damaged yoke.

e. Reassembly.

(1) Install washers (7, 8, and 9, fig. 10–3) on splined yoke (12).

(2) Install lubrication fittings (13) in sleeve yoke (14).

(3) Coat interior of sleeve yoke (14) and exterior of splined yoke (12) with grease (GAA). Slide splined yoke partially into sleeve yoke.

(4) Install springs (10) and balls (11) in slots of splined yoke and slide yoke completely into sleeve yoke.

(5) Compress springs behind washers and install retaining ring (6) in groove to hold parts in place.

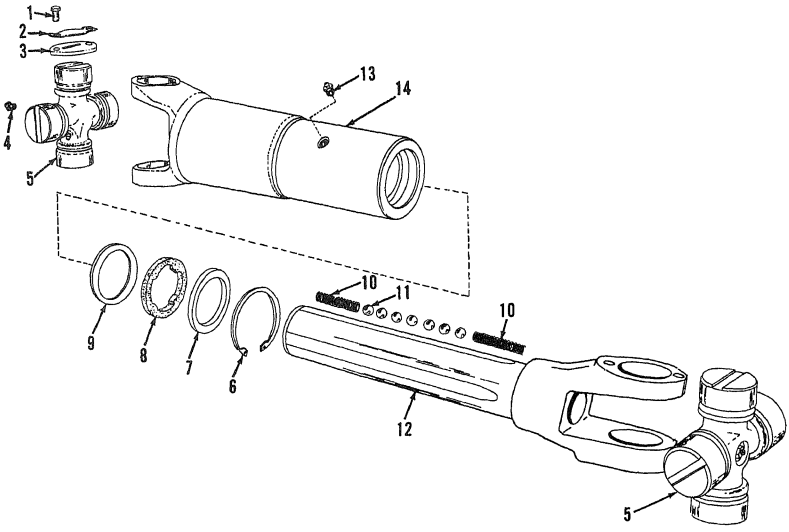
(6) Install lubrication fittings (4) in cross and bearing assemblies (5) and install cross and bearings in yokes and secure with four cover plates (3), lock plates (2), and screws (1).

Note. Remaining plates will be installed when drive shaft is installed on loader.

f. Installation. Refer to TM 5–3805–239–12 and install the center drive shaft on the loader

10–5. Front Drive Shaft

a. Removal. Refer to TM 5–3805–239–12 and remove front drive shaft (1, fig. 10–1) from the loader.



1 Screw, cap, hex-head, 5/16-24 x 1/2 in. (16 rqr)
2 Lock plate (8 rqr)
3 Cover plate (8 rqr)
4 Lubrication fitting (2 rqr)
5 Cross and bearing assembly (2 rqr)
6 Ring, retaining
7 Guide washer
8 Washer, felt
9 Washer, thrust
10 Spring (8 rqr)
11 Ball (28 rqr)
12 Spline yoke
13 Lubrication fitting (2 rqr)
14 Sleeve yoke

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Figure 10–3. Center drive shaft, exploded view.

b. Disassembly.

(1) Remove screws (1, fig. 10–4), lock plates (2), and cover plates (3). Remove cross and bearing assembly (5) from yoke. Remove lubrication fitting (4).

(2) Remove dust cap (6), washers (7 and 8), and plug (9) from slip yoke (10).

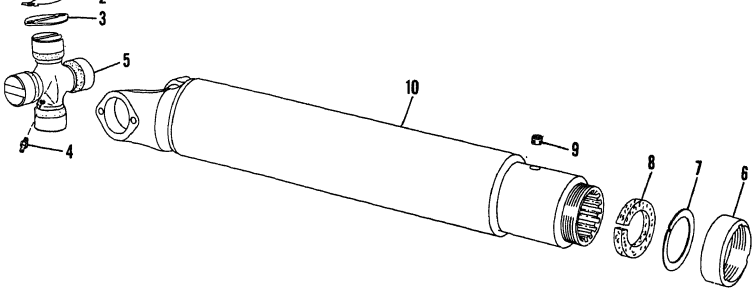
c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

d. Inspection and Repair.

(1) Inspect cross and bearing for wear and damage. Replace defective parts.

(2) Inspect dust cap and washers for damage and deterioration. Replace defective parts.

(3) Inspect slip yoke for damage to splines and threads and cracks to yoke. Replace yoke if damaged.



1 Screw, cap, hex-head, 5/16-24 x 1/2 in. (8 rqr)
2 Lock plate (4 rqr)
3 Cover plate (4 rqr)
4 Lubrication fitting
5 Cross and bearing assembly
6 Dust cap
7 Washer
8 Washer, felt
9 Plug
10 Slip yoke

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Figure 10–4. Front drive shaft, exploded view.

e. Reassembly.

(1) Install washers (7 and 8, fig. 10–4) on yoke (10). Install dust cap (6) but do not tighten.

(2) Install plug (9) in yoke (10).

(3) Install lubrication fitting (4) in cross and bearing assembly (5). Install cross and bearing assembly in yoke (10) and secure with two cover plates (3), lock plates (2), and four screws (1).

Note. Remaining plates will be installed when drive shaft is installed on loader.

f. Installation. Refer to TM 5–3805–239–12 and install the front drive shaft on the loader.

10–6. Bearing and Support

a. Removal

(1) Refer to TM 5–3805–239–12 and disconnect front and center drive shafts (1 and 2, fig. 10–1) from bearing and support assembly (6).

(2) Remove from screws (4) and nuts (5) and remove bearing and support assembly (6) from frame.

b. Disassembly.

(1) Remove self-locking nut (1, fig. 10–5) and washer (2). Remove yoke (3) from shaft (8) using a suitable puller.

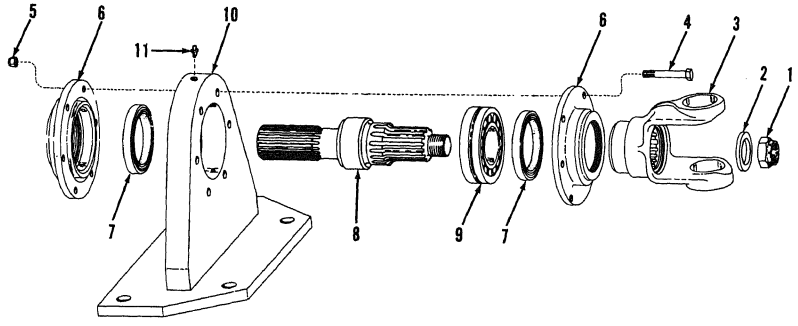
(2) Remove six screws (4) and self-locking nuts (5) and remove two covers (6) from bracket (10).

(3) Remove shaft (9) from bracket (10) by tapping with a soft hammer.

(4) Press bearing (9) from bracket (10) using a suitable press.

(5) Do not remove oil seals (7) from covers (6) unless replacement is necessary. Pry seals from cover to remove.

c. Cleaning. Clean all metal parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.



1 Nut, self-locking
2 Washer
3 Yoke
4 Screw, cap, hex-head, 3/8-24 x 3 in. (6 rqr)
5 Nut, self-locking, 3/8-24 (6 rqr)
6 Cover (2 rqr)
7 Oil seal (2 rqr)
8 Shaft
9 Bearing
10 Bracket
11 Lubrication fitting

MEC 3805-239-12/10-5

Figure 10–5. Bearing and support, exploded view.

d. Inspection and Repair.

(1) Inspect yoke for cracks and for damage to splines. Replace damaged yoke.

(2) Inspect shaft for damaged splines and for wear and damage to bearing surface. Replace worn or damaged shaft.

(3) Inspect bearing for wear and damage. Oil bearing and rotate. Bearing must rotate freely without binding. Replace worn or damaged bearing.

(4) Inspect covers for cracks and damage and for damage to oil seal surfaces. Replace damaged covers.

(5) Inspect support bracket for wear and damage, particularly to bearing surfaces in bore of bracket. Replace damaged or worn bracket.

e. Reassembly.

(1) Install oil seals (7, fig. 10–5) in covers (6) using a suitable installation tool.

(2) Press bearing (9) into bore of bracket (10). Press shaft (8) into bearing.

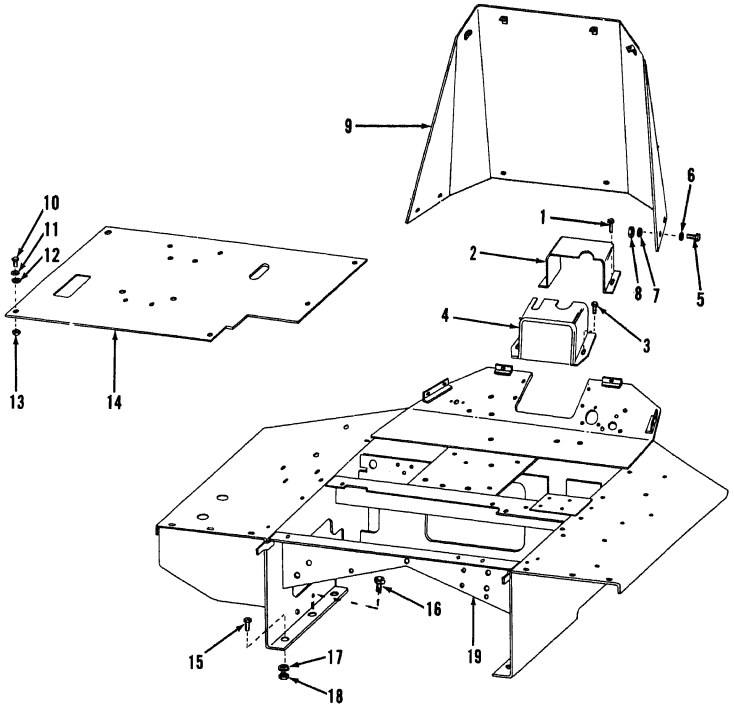
(3) Install covers (6) on bracket and secure with screws (4) and nuts (5).

(4) Install yoke (3) on splines of shaft and secure with washer (2) and nut (1).

f. Installation.

(1) Install bearing and support assembly (6, fig. 10–1) on frame and secure with screws (4) and (5). Tighten nuts to a torque of 200 to 220 foot-pounds.

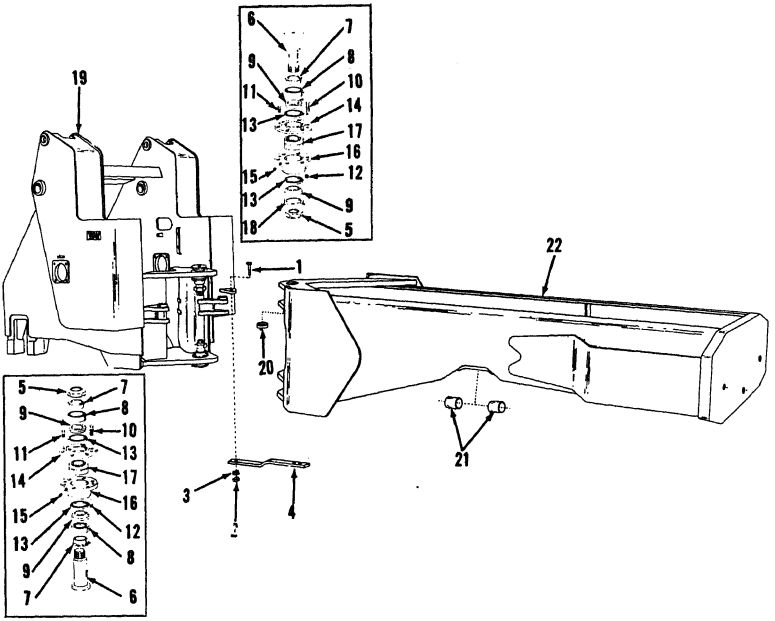
(2) Refer to TM 5–3805–239–12 and connect front drive shaft (1) and center drive shaft (2) to bearing and support assembly.



1 Screw, self-tapping (2 rqr)
2 Cover
3 Screw, self-tapping (2 rqr)
4 Cover
5 Screw, cap, hex-head, 3/8-24 x 7/8 in. (6 rqr)
6 Washer, flat, 3/8 in. (6 rqr)
7 Washer, lock, 3/8 in. (6 rqr)
8 Nut, 3/8-24 (6 rqr)
9 Front cowl
10 Screw, cap, hex-head, 3/8-24 x 1-1/4 in. (5 rqr)
11 Washer, flat, 3/8 in. (5 rqr)
12 Washer, lock, 3/8 in. (5 rqr)
13 Nut, 3/8-24 (5 rqr)
14 Floor plate
15 Screw, cap, hex-head, 5/8-18 x 2 in. (4 rqr)
16 Screw, cap, hex-head, 5/8-18 x 3 in. (2 rqr)
17 Washer, flat, 3/8 in. (6 rqr)
18 Nut, self-locking, 5/8-18 (6 rqr)
19 Platform

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Figure 10-6.



1 Screw, cap, hex-head, 1-12 x 3-1/4 in. (2 rqr)
2 Nut, 1-12 (2 rqr)
3 Washer, lock, 1 in. (2 rqr)
4 Safety locking bar
5 Nut, self-locking (2 rqr)
6 Pivot pin (2 rqr)
7 Collar (3 rqr)
8 Collar (3 rqr)
9 Boss (4 rqr)
10 Screw, cap, hex-head, 5/8-18 x 3-1/4 in. (12 rqr)
11 Screw, self-locking, 3/8-16 x 1-1/8 in. (4 rqr)
12 Nut, self-locking, 5/8-18 (12 rqr)
13 Seal (4 rqr)
14 Bearing retainer (2 rqr)
15 Lubrication fitting (2 rqr)
16 Bearing retainer (2 rqr)
17 Self-alining bearing (2 rqr)
18 Spacer
19 Frame front section
20 Bearing
21 Sleeve bearing (2 rqr)
22 Frame rear section

MEC 3805-239-35/10-7

Figure 10-7.

10–7. General

a. The frame is a welded steel heavy duty type support for the loader. The rear of the frame is designed to support the engine, transmission, and their attached components.

b. The platform is designed to support the operator's seat and controls and to mount a cowl for protection of the front of the platform and operator's compartment.

10–8. Platform

a. Removal.

(1) Refer to TM 5–3805–239–12 and remove the following:

(*a*) Seat assembly.
(*b*) Parking brake lever and linkage.
(*c*) Control levers and linkage.
(*d*) Transmission control lever and linkage.
(*e*) Air reservoir and lines.
(*f*) Power cluster and lines.
(*g*) Miscellaneous electrical components.
(*h*) Hydraulic reservoir, control valve, an lines.
(*i*) Instrument panel.
(*j*) Air horn and lines.
(*k*) Air cleaner.
(*l*) Aicohol evaporator.
(*m*) Cold weather starting aid.
(*n*) Tandem hydraulic pump and lines.
(*o*) Power steering and lines.
(*p*) Batteries and battery box.
(*q*) Tool box.
(*r*) Hood, fenders, and ladder.
(*s*) Air cleaner shield.
(*t*) Handle and hand rail.
(*u*) Safety locking bar.

(2) Refer to paragraph 2–33 and remove the steering gear assembly.

(3) Refer to paragraph 2–34 and remove the dual air application valve and brake pedals.

(4) Refer to paragraph 2–35 and remove the demand valve.

(5) Remove six screws (5, fig. 10–6), washers (6 and 7) and nuts (8) and, using a suitable hoist, lift front cowl (9) from loader.

(6) Remove five screws (10), washers (11 and 12), and nuts (13) and, using a suitable hoist, remove floor plate (14) from loader.

(7) Remove four screws (15), two screws (16) and six washers (17) and nuts (18) and, using a suitable hoist, remove platform (19) from loader.

Note. Covers (2 and 4) were removed when steering gear was removed.

b. Cleaning. Clean all parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

c. Inspection and Repair.

(1) Inspect platform, cowl, and floor plate for cracks, dents, bends, and loose or broken welds.

(2) Repair components by welding if possible. If part cannot be repaired, replace the part.

d. Installation.

(1) Lift platform (19, fig. 10–6) with a suitable hoist and install platform on loader frame and secure with four screws (15), two screws (16), and six washers (17) and nuts (18).

(2) Lift floor plate (14) with a suitable hoist and install on platform. Secure floor plate with five screws (10), washers (11 and 12), and nuts (13).

(3) Lift front cowl (9) with a suitable hoist and install on platform. Secure cowl with six screws (5), washers (6 and 7), and nuts (8).

(4) Refer to *a* above and reverse steps (1) through (4) to complete assembly of the loader.

10–9. Frame

a. General. The frame is in two sections connected by pins rotating in bearings. The two sections can be separated by removing the pins.

b. Removal.

(1) Refer to paragraph 10–8 and remove the platform and cowl.

(2) Refer to TM 5–3805–239–12 and remove the following components.

(*a*) Bucket.
(*b*) Lift and dump cylinders and lines.
(*c*) Boom and cross links.
(*d*) Steering cylinders and lines.

(3) Refer to paragraph 2–30 and remove the engine.

(4) Refer to paragraph 2–31 and remove the transmission.

(5) Refer to paragraph 2–32 and remove front and rear axles from loader.

(6) Support front section (19, fig. 10–7) with a suitable hoist and blocking.

(7) Remove two nuts (5) and tap pins (6) from frames. Lift front section (19) from rear section (22) and place on suitable blocks.

(8) Disassemble bearings as follows:

(*a*) Remove collars (7 and 8) and spacer (18) from front section (19).

(*b*) Remove screws (10) and nuts (12) and tap bearing retainers (14 and 16) from front section.

(*c*) Remove screws (11) and separate bearing retainers (14 and 16).

(*d*) Remove self alining bearings (17) from retainers. Remove bosses (9) from retainers.

(*e*) If seals (13) require replacement, remove seals from retainers.

(9) Drive bearings (20 and 21) from bores in rear section (22).

(10) Remove lubricating fittings (15) from retainers (16).

c. Cleaning. Clean all parts in cleaning compound, solvent (Spec. P–S–661) and dry thoroughly with compressed air.

d. Inspection and Repair.

(1) Inspect self alining bearings for wear and damage. Replace worn or damaged bearings.

(2) Inspect bearing retainers for wear and damage to bearing bores. Replace defective retainers.

(3) Inspect pivot pins for wear and damage, especially to threads. Replace defective pins.

(4) Inspect bearings in rear frame for wear and damage. Replace damaged or worn bearings.

(5) Inspect front and rear sections for cracks, damage, and loose or broken welds. Repair sections by welding if possible. Replace sections if they cannot be repaired.

e. Installation.

(1) Install oil seals (13, fig. 10–7) and bosses (9) into bearing retainers (14 and 16).

(2) Press self-alining bearings (17) into bearing retainers (16).

(3) Secure retainers together with screws (11). Install assembled retainers in front section (19) and secure with screws (10) and nuts (12). Tighten nuts to a torque of 55 to 60 foot-pounds.

(4) Install collars (7 and 8) in bearing assembly.

(5) Install bearings (20 and 21) in bores in rear section (22) using a suitable driver.

(6) Lift assembled front section (19) with a suitable hoist and guide it into line with rear section (22) pivot points.

(7) Install pivot pins (6) through rear section and bearing assembly in front section. Secure pins with nuts (5). Tighten nuts to a torque of 2000 foot-pounds.

(8) Refer to paragraph 2–32 and install the axles.

(9) Refer to paragraph 2–31 and install the transmission.

(10) Refer to paragraph 2–30 and install the engine.

(11) Refer to paragraph 10–8 and install the platform and cowl.

(12) Refer to TM 5–3805–239–12 and install the following components.

(*a*) Boom and cross links.

(*b*) Lift and dump cylinders and lines.

(*c*) Bucket.

(*d*) Steering cylinders and lines.

CHAPTER 11

WELDING PROCEDURES

Section I. GENERAL

11–1. Description

The frames, boom, lift links, platform assembly, and bucket of the loader are welded to maintain the rigidity and support required in loader operations. The weldments, as manufactured, are of long durability and should cause little or no trouble during the life of the loader.

11–2. Special Steels

a. Steel used in the loader frame is standard steel with no special application or welding techniques required.

b. The bucket (Drott Manufacturing Part Number 951927) has special steel incorporated in the construction and requires the separate procedures as detailed below.

Section II. WELDING PROCEDURES

11–3. Preparation

a. Preheating. No preheating of the metal is required.

b. Cleaning. The metal does not require grinding to prepare it. However, chip and clean it to remove dirt, grease, scale, paint, and loose metal from the weld areas.

11–4. Welding Procedures

a. Shielding Medium. The shielding medium will be a rate of flow of 35 to 45 pounds of CO_2 (carbon dioxide).

b. Bucket Weld Areas. Refer to figure 11–1 for weld areas, types of steel, and welding rods to be used.

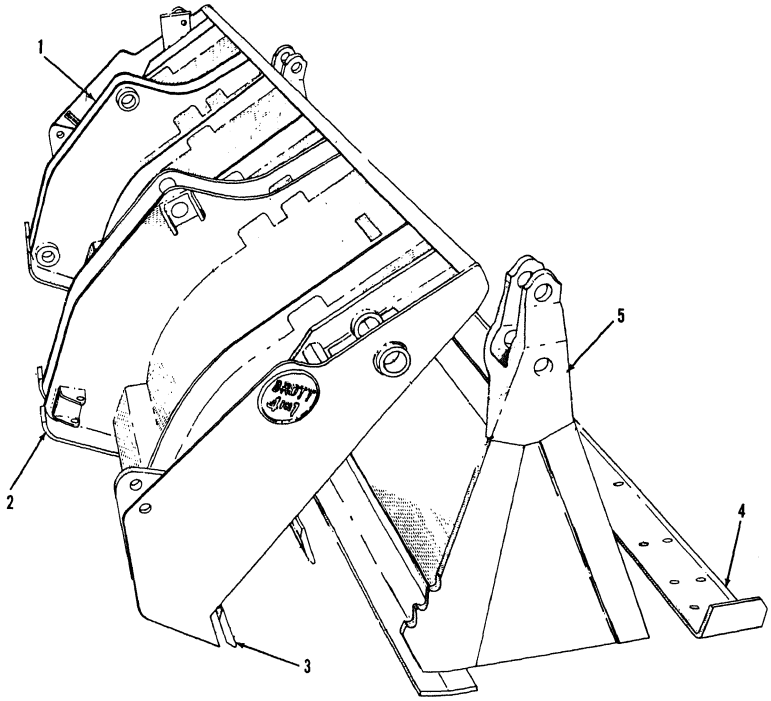
Note. All steel used is MAN TEN except where indicated.

c. Cleaning. Scale and surface scale should be removed by chipping or with a wire brush before depositing another layer. Clean in same manner when weld is finished.

d. Post Weld Heat Treatment. No heat treatment to relieve stress is required after welding process is completed.

11–5. References

For further information and welding applications refer to TM 9–237.



1. Brackets. Steel - A-36. Weld Rod - Class E-7014 or E-7024.
2. Shoes. Steel - C-1060. Weld Rod - Class E-7018 or E-9016.
3. Moldboard Blade and Corner Bits. Steel-1084.
4. Bucket Blade. Steel - C-1060. Weld Rod - Class E-7018 or E-9016.
5. Clam Casting and Hinges. Steel - ASTM-A-148-158. Class 80-50. Weld Rod - Class E-7018 or E-9016.

NOTE: All Other Steel is MAN TEN. For This Steel Use Weld Rod Class E-7014 or E-7024.

MEC 3805-239-35/11-1

Figure 11-1. Bucket Welding Procedures.

APPENDIX A

REFERENCES

A–1. Lubrication

C9100IL LO 5–3805–239–12	Fuels, Lubricants, Oils and Waxes

A–2. Fire Protection

TB 5–4200–200–10	Hand Portable Fire Extinguishers for Army Users

A–3. Painting

TM 9–213	Painting Instructions for Field Use

A–4. Radio Suppression

TM 11–483	Radio Interference Suppression

A–5. Maintenance

TM 9–1870–1	Care and Maintenance of Pneumatic Tires
TB Ord 651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems
TM 5–3805–239–12	Operators and Organizational Maintenance Manual
TM 9–6140–200–15	Operator and Organizational, Field and Depot Maintenance Storage Batteries, Lead Acid Type
TM 38–750	Army Equipment Record Procedures
TM 5–764	Electric Motor and Generator Repair

A–6. Shipment and Storage

TB 740–93–2	Preservation of USAMEC Mechanical Equipment for Shipment and Storage

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